

Scientific Research and Economic Activity:
The Perceptions of Academic and Industrial Scientists of the
Production and Capitalization of Knowledge

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By
James Sefe Dzisah

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Head of the Department of Sociology
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Abstract

Knowledge production has changed considerably in the past few decades. This transformation has notably affected universities both as unique institutions and citadels of knowledge. These changes are being brought by a number of factors, such as the globalization of the economy, the rise of technologies based on generic forms of knowledge, and the ability of universities to hold and exploit patents. In both scale and intensity, these alterations have led policy makers to reflect more on how scientific and technological innovation can and should be enhanced by policy decisions that would improve university-industry and government cooperation. This new fusion of three complementary societal sectors has been described by sociologists as the *triple helix*. As an analytical and normative concept, the *triple helix* is derived from the changing role of government in different societies in relation to academia and industry. Its basis is the recognition that the interaction among university-industry-government as relatively independent, yet inter-dependent institutional spheres is critical to improving the conditions for innovation in a knowledge-based society.

The study reveals that commercial research funding significantly affects the perceptions of university-industry collaboration and academic knowledge capitalization. The analysis showed that academic scientists who received commercial research funding have relatively positive views about university-industry relations than those who do not receive such funds. However, one cannot conclude that commercial activities of academic scientists are harming the core functions of the university or that intellectual autonomy is being surrendered to industrial partners. Based on the findings of the study, and the contours of the triple helix model, it is argued that the growth of university-industry-government collaboration is not necessarily pre-determined in favour of either private corporations or the state, nor is it necessarily at the expense of universities. It is further contended that the growing notion that academic capitalism is harming the core functions of the university is perhaps a bit simplistic in that the issue is more complex and multifaceted than usually acknowledged.

In light of the above, the study asserts that the future viability of policies encouraging universities to be entrepreneurial may, if approached strategically, be catalysts for the science-based knowledge economy. For that to be realistic there is the need to understand the university as a ‘differentiated social system’ rather than a ‘unified whole’. This will avoid the situation whereby all university activities are subordinated under a homogenous policy of one size fits all. In the context of *triple helix* relations, conceptualizing the university as a ‘differentiated social system’ means a deep-seated and continually growing purposeful specialization such as the adoption of an economic development function in addition to teaching, research and community engagement.

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Dedication

To my father:

William Kwaku Dzisah

‘The great inspirer, motivator and a pace-setter.’

And

To the memory of my beloved mother:

Vincentia Aku Galley-Dzisah

‘The conscientious organizer.’

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Chapter One

1.1.0 Introduction to the Study

The globalization of the economy through the advances in information and communication technologies (ICTs) has resulted in a diminishing gap between research and utilization. These changes have occurred almost simultaneously with increasing recognition of the dual theoretical and practical impetuses for scientific research (Etzkowitz, Schuler and Gulbrandsen, 2000). Whilst the process of the capitalization of academic scientific knowledge is not benign across university campuses, recent acceleration of the process has generated much debate in many circles. The dominance of these debates in the sociological literature is understandable from the perspective that the study of the nature and causes of the transformation of universities is a relatively new area of interest.

In spite of this, scientific research and economic activity are linked on several levels. In terms of university—industry—government relations, the linkage is exemplified by various attempts at the development of science and technology parks, centres of excellence, and other university-based research innovators (Castells and Hall, 1994; Etzkowitz and Leydesdorff, 1997). While the explicit nature, the sheer size of the practice, and the manner in which “policies encouraging the university to become a driver

of science-based knowledge economy" (Etzkowitz, 2002:1) are being pursued are novel in many ways, the transformation of academic science into economic outcome is as old as modern universities (Jacob and Stewart, 2004). The reality is that modern universities are established to aid the economic development and competitiveness of their respective locales, regions and nations. In this regard, they are established, nurtured and fueled with public dollars not only to aid the production, translation, and preservation of knowledge, but also to serve as conduits through which scientific research could be transformed to enhance the socio-economic interests of the citizenry. In essence, universities are meant to aid and quicken the production of human and social capital with the expectation that both will in the long run be combined for producing economic capital. However, the nature, substance, and structure of these economic development tasks are often ambiguously left to the discretion of various stakeholders—university faculty and administration, private sector industries, local, regional, and federal governments.

In spite of the fact that universities for a long time have been actively involved in the practicalities of the world (Jacob and Stewart, 2004), until recently, attempts were made to distinctively separate university and industrial research (Kleinman, 1995). This distinction in a way makes for a superficial policing of boundaries, and thus, draws a thin line between scholarly and industrial research. This veneer notwithstanding, basic and applied sciences do interact in a variety of ways, particularly through consultancy work done for industry by some academic faculty (Etzkowitz, 2002). However, in the rigorous sense of the distinction between basic and applied science, “academe was perceived as doing the necessary fundamental science that often preceded application and industrial development” (Croissant, Rhoades and Slaughter, 2001:108—109). The outcome of this

separation was that it left “control of commercial opportunities of academic research in the hands of industry whereas control over the direction of research and the choice of research topics was left to academic scientists” (Etzkowitz, 2002:13). However, the crossings of boundaries have not abated but rather continue to gradually increase. As a result, some academic scientists have come to fully embrace entrepreneurial culture in their research undertakings (Etzkowitz, 2002).

It should be noted that several factors, such as, the rise of technologies based on generic forms of knowledge that underpin a diverse range of industrial sectors without being unique to any one sector, the erosion of universities grant economy, the ability of universities to hold and exploit patents, the gradual breakdown of boundaries between basic and applied research particularly evident in the field of biotechnology have greatly contributed to the blurring of these institutional boundaries (Baber, 2001:402—3; Etzkowitz, Webster and Healy, 1995). Consequently, the latter part of the twentieth century has seen an increasing number of academic scientists moving further toward capitalizing their scientific research (Etzkowitz, 2002). There is, thus, an ongoing transformation of most public universities through the translation of academic scientific research and their intellectual property into patents, spin-off firms, and joint venture companies in order to aid the socio-economic development and regeneration of their respective locales, regions and countries.

With the emergence of a ‘global informational economy’ (Castells, 1993), the need to translate research into products and new enterprises has never been greater. The outcomes of these shifts are the “shortening of the time span between discovery and utilization, and increased reliance of industry on knowledge originated in academic

institutions” (Etzkowitz, Webster and Healey, 1998:2). In the realization of these objectives, the implicit missions of universities—the production of knowledge, publication of research, training of graduates and community engagement—have taken on new dimensions. For instance, there is now the networking and the interconnection of research agendas across disciplinary and institutional boundaries. These transformations demand a sociological attempt to understand how knowledge is produced, communicated, and improved (Calhoun, 2006).

In this study, the *triple helix* of university—industry—government model is used to analyze new linkages that transcend the traditional mission of universities. The *triple helix* interface considers the result of an interaction between functional and institutional dynamics in society (Etzkowitz and Leydesdorff, 1997). It recognizes this interaction as key to improving the settings for innovation in a science-based knowledge economy. As formulated, the *triple helix* accounts for the numerous reciprocal relationships among institutional sectors at different points in the knowledge capitalization process. As such, in order to examine the underlying forces at work in the transformation of academic scientific research from the perspective of academic and industrial scientists, survey research method is used. In all thirty professors, eighteen associate professors, thirteen assistant professors and sixteen corporate representatives were surveyed. In addition, twelve professors were interviewed and their responses analyzed in the qualitative segment of the study. In terms of the academic survey, the sample to a large extent reflects the academic landscape in terms of academic rank and gender at the University of Saskatchewan.

The study noted that the search for strategic policies that will adequately re-energize innovation systems across regions has not only resulted in numerous university—community initiatives but has also produced diverse knowledge capitalization schemes. These strategic policies have openly encouraged most public universities to contribute to the socio-economic development of their regions as dynamic entrepreneurs. Based on these institutional transformations, one should be looking beyond the romanticized ‘ivory tower’ image of universities, and view them as catalysts for the science-based knowledge economy.

Though universities have been undergoing deep structural changes with profound implications, past studies of university-industry interaction were overly concerned with the impact that private corporate interests were having on the public charge of universities, without any proper cost-benefit analysis. Consequently, one of my theses is that the growth of university—industry—government collaboration is not necessarily pre-determined in favour of either private corporations or the state, nor is it necessarily at the expense of universities. In addition, the growing notion that university—industry relations are harming the core functions of the university is perhaps a bit simplistic in that the issue is more complex and multifaceted than acknowledged in the social studies of science literature.

In light of the above, it is asserted that the future viability of policies encouraging universities to be entrepreneurial may, if approached strategically, be a catalyst for the science-based knowledge economy. However, for this direction to be clear there is the need to first understand the university as a ‘differentiated social system’ rather than a ‘unified whole’ where all research and administrative policies are considered to be

identical. By understanding the university as a ‘differentiated social system’, the various colleges and departments should be encouraged to focus on their diversity in terms of institutional resources, requirements, and capabilities. The concept of the university as a ‘differentiated social system’ is based on Luhmann’s (1982 and 1996) characterization of internal differentiation. He acknowledges that forms of differentiation determine the degree of complexity that a society can attain. In the context of university—industry—government relations, this differentiation should enable the university to pursue all its functions without any particular one being overshadowed.

In other words, there will be a deep-seated and continually growing purposeful specialization such as the adoption of economic development roles in addition to teaching, research and community engagement. This understanding should supersede the way we currently view the university as a ‘unified social system’, which in principle, denotes the subordination of all activities under a homogenous policy of one size fits all. This is not meant to deny the fact that negative consequences are embedded in the capitalization of scientific research. There is, therefore, the need for policy guidelines that will ensure that outcomes of the university’s economic ventures are equitably distributed across various academic segments. These guidelines should also detail the ways by which capitalized scientific research will be managed whereby benefits are sustained and negative consequences minimized.

Contemporary academic transformations demand a sociological prognosis that will effectively combine elements from approaches based on both agency and structure if we are to adequately look beyond the ‘ivory tower’ and the idealized linear model of knowledge production. This requires a dynamic shift in our focus from individualized

institutions of knowledge production to an interactive evolutionary model of innovation such as the *triple helix* of university—industry—government relations. Long ago, Karl Marx noted in his eleventh thesis on Feurbach that ‘philosophers have interpreted the world in various ways. The time has come to change it’. Whether we are changing the world by reacting to socio-economic and political demands on the university or just giving change a cosmetic look by trading public goods for private gains requires additional sociological inquiry. However, it is clear that the “traditional university conveyed inequality as effectively as does market-driven higher education today” (Ohmann, 2003:85). Changes are taking place around our various campuses as the university is called upon to dynamically propel the science-based knowledge economy. It is a mission of contradictions that will require significant functional and institutional re-organizations. With these in mind, the next section explores the transformation of higher education in North America using the United States (US) and Canada as anchors.

1.1.1 The Transformation of Higher Education in the US and Canada

During the nineteenth-century, almost all distinct groupings in America felt impelled to set up their own colleges, both to perpetuate their distinctive sub-culture and to give it legitimacy in the larger society. The entrepreneurs who set up these colleges rarely undertook any market research before opening their doors. In this period of uncertainty, most of these entrepreneurs were ready to redefine or blur their initial aims as a survival mechanism. Consequently, in the “evolution of colleges as of species, older and apparent rationality emerged through natural selection and adaptation over time rather than from, the initial mutations” (Jencks and Riesman, 1969:2-4). In spite of this, the most significant basic change in higher education in North America has been the

gradual rise of the university. Though Yale awarded the first PhD in 1861, it was not until the 1880s that anything like a modern university really took shape in the United States.

In Canada, McGill University was founded in 1821 and King's College—the precursor to the University of Toronto—was granted its royal charter by King George IV on March 15, 1827. However, it was not until 1897 that the PhD degree was introduced in a Canadian university. Nonetheless, the Master of Arts degree had had a long history at the University of Toronto. It had been awarded from the first convocation of King's College and subsequently been awarded since by the University of Toronto. At that time, the degree was not highly regarded as no special courses were provided, nor was residence at the university required. In the early period, the thesis was actually written in an examination hall without reference to books (<http://www.greatpast.utoronto.ca/>. Accessed, April 04, 2006).

In the U.S, by the end of World War I, two-dozen major universities had emerged. While the number has grown since then, the changes in the form and content of these universities have always been slow. These universities have long been remarkably similar in what they encouraged and value. They turn out PhDs who, despite conspicuous exceptions, have relatively similar ideas about what their disciplines entail, how they should be taught, and how their frontiers should be advanced (Jencks and Riesman, 1969). The Second World War and its outcome greatly strengthened these outlooks. Academic scientists helped contribute to the war effort, leading partly to a remarkable increase in federal support for academic research. This support soon became accessible not just in the physical, biological, and social sciences, but small sums were also going to the humanities. Unlike past support for universities, these federal grants and contracts were

for all intents and purposes given to the individuals or groups of scholars rather than to the institution where they happened to work. As such, when professors changed institutions, they did so with their federal grants. In addition, these federal grants were made largely on the basis of individual professional reputation and competence. The result has been a further enhancement of the “status of the academician, who is now a prime fund raiser for his institution” (Jencks and Riesman, 1969:14-5). In addition, the transfer of power from boards of directors to professional administrators has not been confined to higher education. Despite some notable exceptions, today’s university presidents usually start out as members of the professoriate. When they become administrators and have to deal more often with other stakeholders, they inevitably become somewhat deprofessionalized (Jencks and Riesman, 1969).

In almost any discussion of American higher education, somebody is likely to put forward the idea that the nation’s colleges have been corrupted by vocationalism. It will be argued that in the good old days:

Colleges were pure and undefiled seats of learning. Students came to get a liberal education, not a degree in accounting, mortuary science or X-ray technology. The professors, in turn, were interested in broadening minds of the young, not advancing themselves through government contracts, business consulting, or publication poundage (Jencks and Riesman, 1969:199).

Like other pastoral idylls, this myth serves all sorts of polemical purposes, good and bad. In fact, there was no golden age in American higher education. Young men of college age worried about their future careers in the colonial era just as they do today, and this affected both the kind of men who came to college and the kind of things they did upon arrival (Jencks and Riesman, 1969:199). During the colonial era people usually went to college because they hoped to become clergymen; today they go because they hope to become doctors, lawyers, teachers, business executives, and the like. While this is an

important change, and has affected the character of higher education, it does not imply either a rise or decline in vocationalism. The same is true of the faculty (Jencks and Riesman, 1969:199). Though much has changed in higher education, the purity of motive and single-mindedness of purpose have never been characteristic of American colleges and the question has always been how an institution mixed the academic with vocational, not whether or not it did so. Admittedly, progress costs something, and advances in the direction of one value are almost always detrimental to some other values (Jencks and Riesman, 1969).

In fact, the history of the transformation of Canadian higher education, though unique and distinct in numerous ways, parallels that of the United States. It is a history punctuated with twists and turns, and a struggle for inclusion. In spite of this, the Canadian university system grew very rapidly in the post—war period. Though as of 1950, doctoral research was confined only to the University of Toronto and McGill University, Canadian university research was nevertheless expanding and was being financed mostly by National Research Council (NRC) grants. University research funding climbed to about \$3.75 million per year in the late 1950s, but always seemed insufficient (Niosi, 2000:45). Compared to the US, Canadian higher education has been chronically starved by a lack of funds. In 1963, the ratio of US to Canadian expenditures on university research was 40 to 1. By 1969, it was 14 to 1, and there were some thirty research universities in Canada (Niosi, 2000; Lithwick, 1969:27).

From Confederation to the mid—1960s, university research was financed mostly by internal funds; other major sources were the federal government, which reimbursed provinces for at least 50 per cent of the operating costs of higher education, and later the

NRC research grants and scholarships (Niosi, 2000). Though the provinces were responsible for education, including universities, the federal government had to support these institutions or watch them suffer from lack of funds. In 1968—1969, university research in Canada cost some \$125 million, of which 69 per cent came from the federal government, mostly through the NRC and the Medical Research Council (MRC), 14 per cent from the provincial governments, 8 per cent from foundations, 3 per cent from business, and 6 per cent from other sources (Niosi, 2000:45-6). In 1968—1969, universities awarded some 60,000 bachelor's and first professional degrees, of which 1.2 per cent were in agriculture and forestry, 11.1 per cent in sciences, and 5.9 per cent in engineering and applied arts. They also conferred some 11,000 graduate degrees, of which 6.8 per cent were in agriculture and related sciences, 12.4 per cent in sciences, and 11.2 per cent in engineering and applied sciences. In other words, 18 per cent of all graduates with first university degree and 30 per cent of all undergraduate degrees were in disciplines related to industry, natural science, and technology (Niosi, 2000:46).

In Canada, the dawn of the modern version of university—industry—government research relations was furthered in the 1980s, when the main funding councils, Medical Research Council (MRC), Natural Sciences and Engineering Research Council (NSERC), and the Social Sciences and Humanities Research Council (SSHRC) created matching policies to promote collaboration between industry and universities. The result of these and similar policies was an upsurge in industry-university collaboration (Niosi, 1995). The systemic effects of these changes were significant. They brought with them further fundamental changes in the methods and procedures of allocating research funds, the “mandates, missions, evaluation procedures, and effectiveness criteria of government

laboratories” making technological cooperation key to the implicit goal of increasing both “revenues and visibility” (Niosi, 2000:53). The ripple effect of these deep-seated changes on Canadian universities was that the evaluation of public research institutions, which is usually conducted via publications and citations, was progressively shifted to standards that were based on their overspills into the economy, mainly on employment and production. In the 1990s, there was an upsurge in the economic evaluation of academic efforts, as a means of rationalizing public dollars spent in terms of public welfare. These developments were due to transformations in the global economy and the shift to greater dependence on knowledge couched in terms of science and technology (Niosi, 2000).

In the 1990s university laboratories had become the second largest institutional actor in the national R&D system, relegating government labs to third place. By 1990, Canada had the world’s highest percentage of twenty-two year-olds with first college and university degrees: some 33 per cent of Canadians at that age had a higher education diploma. However, only 18 per cent of them had a degree in natural sciences or engineering. By comparison, 31 per cent of US twenty-two-year-olds had a higher education degree, and 13 per cent of them were in natural science or engineering (Niosi, 2000:56-61). In addition, the links between industry and universities were developing rapidly. A governmental study estimated that in 1980 business funded 4 per cent of university R&D, and in 1993, 11 per cent, against only 7 per cent in the US (Niosi, 2000).

Furthermore, by 1995 Canadian universities were spending some US \$2.3 billion, against US \$27.3 billion by American universities—a ratio of 1 to 12 (Niosi, 2000). It is clear that the trajectory of the modern university is not one of a linear development. It is a history in which several ideas have been tried and others discarded. However, what is

common in the development of both the US and Canadian universities are the search for strategies to advance knowledge and the socio-economic interest of the citizenry. With North American higher education selectively put into context, the next section considers the research problem.

1.1.2 Statement of the Problem

The dynamism of scientific research and the transdisciplinary nature of modern knowledge production have added an extra dimension to the transformation of the academic scientific research process. At first, the transformation of scientific research into economic activity was indirectly pursued through the training of graduates the majority of whom ended up working for or with industry. However, since the dawn of Vannevar Bush's (1945) idea of science as an 'endless frontier' and the remarkable success of Silicon Valley and Boston Route 128 (Saxenian, 1994), the realization that there is more to the university than pursuing its traditional functions of knowledge preservation, production and dissemination has given way to a new optimism in terms of linking scientific research to economic activity.

As a result, university—industry—government collaboration has accented the idea that knowledge today is far more 'capitalizable' for economic purposes than in the past. The realization is that ideas are commodities or economic assets that can be used to fuel economic growth and development. In response to this, universities have gone through periods of significant transformations. The first of such shifts in ideology was the incorporation of research into the agenda of most publicly funded universities (Etzkowitz, 2002). This paradigmatic change has since expanded towards the redrawing of boundaries between academic and industrial research. This move aimed at translating

research into products and new enterprises has brought new demands on most universities. A subsequent outcome has been the movement of academic research beyond the publication of research, and the production of graduates towards the capitalization of campus-based research. In the realization of these objectives an entrepreneurial university emerges with its own problems, debates, and controversies.

Though the capitalization of academic knowledge with or without industry partnership is not a novel phenomenon, the sheer proportion and the scale it has taken today has generated remarkable attention and concern in some academic and public spheres (Brooks, 1993; Delanty, 2001; Pelikan, 1992; Turk, 2000; Washburn, 2005). These observers have argued that the pursuit of economic development policies by the university has, and will further, undermine and relegate universities' primary function to the background. Washburn (2005), for instance, argued that corporations are driving the increasing research alliances between universities and industry.

Another dimension of the argument is that the globalization of the economy has diminished a country's chances of competitiveness based on traditional comparative advantage such as natural resources and pools of labour (Porter, 1990). Proponents of this view argue that natural resources have almost outlived their usefulness as a singular fuel of the economies of the industrialized world. To compete in today's global economy, they argued, demands that a country build on its intellectual strengths as well as its new comparative advantages—human capital, science, technology and knowledge. As a result, the value of university research and their graduates has been affected. In these circumstances, there are deliberate government policies encouraging universities to take on an expanded role in the economic development of locales, regions and countries

through science and technology-based innovation. They are also encouraged, through new funding incentives and initiatives, to translate academic science into economic outcomes. In furtherance of these policy directions, the Science Council of Canada asserts that Canada's need for linkages is especially great in order to move beyond the reliance on bulk commodities by cutting down the time between discovery and application. This, they stated, required finding more efficient mechanisms to deliver discoveries to the marketplace (Science Council of Canada, 1988).

It must be stated that the calls for these functional, institutional and attitudinal changes are not anything new. In Canada, links between universities and industries go back to the 19th century. However, in the past, both universities and industries have never taken these links seriously. The Canadian government, in the past, tried to encourage contributions to research and development from the private sector by tying increases in university research support to corporate contributions to universities or NRC (Gilles, 1989). This stems from the realization that university research can play an important role in socio-economic development and growth renewal. These initiatives whether visions or anomalies are at the heart of recent increases in and the blurring of the boundaries between university and industry.

Nevertheless, the transformation of academic research into economic activity has generated debates especially in terms of ownership. It is here that critics like Polster, (2000) argued in favour of confrontation rather than accommodation of academic capitalism so as to make university generated knowledge a public instead of a private good. The argument is that university-industry-government links have undermined the autonomy of knowledge, academic freedom, and are reinforcing the hierarchical structure

of universities. According to critics, this development is the ceding of control to central administrations and industrial partners to the detriment of the public whose tax dollars are used to prop up the universities (Rhoades and Slaughter, 1991). Stated differently, the claim seems to be that there is “a loss of the university as a community, where individual members are oriented primarily toward the greater good of the organization” (Slaughter and Leslie, 1997:22).

However, the fact that knowledge has become the prime mover of modern advanced capitalism is widely acknowledged. To a degree, Daniel Bell’s prediction about the *Coming of Post-Industrial Society* (1973) has largely been borne out. Consequently, the emergence of the science-based knowledge economy and the transformation of the university into an active player in the global economy have resulted in a ‘structural transformation’ of most public universities (Calhoun, 2006; Habermas, 1989). Although, this may not be the first time for such a structural, functional and attitudinal transformation, the market orientation of current higher education policies are seen by many to be in sharp contrast to an institution that is supposed to be dedicated to the preservation, transmission and conservation of knowledge. In light of this, the study seeks to conduct a broad-based examination of the perceptions of academic and industrial scientists of the production and capitalization of knowledge.

1.1.3 Conceptualizations

The need for excellence in teaching and scholarship coupled with the desire by the public for national economic prosperity have resulted in attempts to put national innovation on the top burner of science and public policy. To attain the goals envisaged

by the national innovation agenda, there has been the call for the shortening of the time span between discovery and application. In this study, the linkage between academic science and economic activity are explored through the *triple helix* of university—industry—government relations. As formulated, the *triple helix* model is adequate for such an exploratory and descriptive understanding not only of the perceptions of academic scientists of the production and capitalization of knowledge, but also, of how the various segments of the university conceive university—industry research partnership and the capitalization of knowledge.

In this study several terminologies have been used in most cases interchangeably. However, the following key terms for the purpose of this study were primarily conceptualized as follows:

1. Capitalization:

- a) The application of human capital stocks by university faculty and administrators in increasingly competitive situations, which results in tandem with the transformation of capital and knowledge creation processes (Etzkowitz, 2003b; Slaughter and Leslie. 1997).
- b) The recognition of ideas as commodities and/or economic assets that can be used to fuel economic growth and development.

2. Commercialization:

- a) The use of university facility by private corporations purposely to maximize their stockholder value, or/and (Woodhouse, 2003).
- b) (i) The licensing of a newly conceived technology from a university, or/ and

(ii) The formation of a new company or/and

(iii) The formation of a joint venture between two parties-university and industry, jointly working on a new technology that may be commercialized at a later stage (Peterman, Harms and Girard, 2001:4).

- c) The adoption of values and practices of corporate management and the displacement of academic criteria by economic criteria in the allocation institutional resources (Polster, 2003).

3. **University-based research innovators:**

- a) Academic scientists, scientific infrastructure—laboratories, science parks, and any other campus-based facilities used in the production of scientific knowledge.

1.1.4 Statement of Purpose

The reasons for my interest in scientific research and economic activity are both academic and practical. The desire largely stems from the fact that the recurrent premise that has emerged across the knowledge capitalization literature is the realization that there is a dynamic shift in the way academic knowledge is produced and utilized. This shift according to some observers will continue to affect the public mission of most universities in numerous ways. Though the debate, more often than not, is centred on what the ideal role of a university is or should be, my interest stems from the fact that the study of the nature and causes of the transformation of universities in terms of *triple helix* of university—industry—government relations is a relatively new area of research. Therefore, the importance of universities in the socio-economic and industrial development of nations is at the core of this study. Also, the need to weave together agency and structure interactions that are embedded within the perceptions of academic scientists is very important, necessary and relevant. Again, a general purpose of this study is to understand the nature of university—industry—government relations at the University of Saskatchewan, and how the academic community generally conceives these relations.

Furthermore, the contradiction that comes with the debate on university—industry relations are another factor underlying this study. Both universities and to a degree industries have been receiving support from their central, provincial and local governments. In spite of this, there have always been attempts to draw a distinct line between universities and industries. Since the ascendancy of a science-based knowledge economy, the artificial boundaries are beginning to be redrawn. It is, therefore, important that we understand whether the transformations of the university are in part, necessitated by forces other than pure commercial interests or not. Thus my intention is to understand the extent of universities' foray into the global marketplace so as to shed light on the socio-economic and political forces at work.

1.1.5 Research Questions

In order to fully grasp the perceptions of academic scientists regarding the production and capitalization of knowledge, there is the need to understand the institutional transformations of knowledge production in a global context. However, to fully understand the formal and informal transformations of academic knowledge production and capitalization at the University of Saskatchewan, I propose to examine the following questions:

1. What is the perception of academic scientists of the production and capitalization of knowledge?
2. Does the presence of university-based research innovators invariably lead to the capitalization of academic knowledge?

3. How and why is the production and capitalization of academic scientific knowledge perceived to be threatening the core functions of most publicly funded universities?
4. How are value conflicts emanating from the capitalization of academic scientific knowledge being resolved?
5. How is the capitalization of academic knowledge viewed and defined by the various sections of the University of Saskatchewan?

1.1.6 Significance of the Study

The global transformations of the economy have in many ways diminished a country's chances of competitiveness based on traditional comparative advantages such as natural resources and pools of labour. To compete in today's global economy, it is necessary for a country to build on its intellectual strengths, as well as, its new comparative advantages—human capital, science, technology and knowledge. It is based on these dynamic transformations that Canada's need for linkage between scientific research and economic activity is very essential. This is needed so as to move beyond the reliance on bulk commodities by developing more efficient mechanisms so as to deliver discoveries to the marketplace (Science Council of Canada, 1988). As such, a study into the transformations of academic research into economic activity is significant in helping us understand its various impacts.

In the United States, the pressure to attend to the commercial implications of research has arisen not only from the emergence of an entrepreneurial dynamic within academia but also from government policies such as the Bayh—Dole Act of 1980. This act has changed the rules for deposition of intellectual property arising from government

funded research. Consequently, this research is significant in that its unit of analysis is academic scientists who are required to provide the link between research and the economy. The significance of this research stems from the contributions that practitioners such as the academic scientists are willing to make towards policy formulations that will guide the innovation process.

Furthermore, despite several attempts by the Canadian government to encourage contributions to research and development from the private sector by tying increases in university research support to corporate contributions to universities or NRC, the links between universities and industries have not been taken seriously (Gilles, 1989; Science Council of Canada, 1988). As such, this study is significant because for some time now, the province of Saskatchewan has been attempting to market itself as a major destination for business. The province's emphasis has been on the available human resources and innovation facilities (Dzisah, 2005). Since the University of Saskatchewan houses the province's major research park and innovation facilities such as the synchrotron, it is important that we understand their role in the production and capitalization of knowledge as well as their contributions to regional socio-economic development.

In addition, though university—industry interaction is not a new phenomenon, the spread of science and technology policy to all regions of the world, irrespective of whether they are research or industrially intensive makes this study significant. Therefore, by conducting this study, our understanding of the perceptions of academic scientists' of the production and capitalization of knowledge will help in terms of policies needed to regulate these nascent developments. This is vital if we are to ensure that equally

important segments of the university that are not directly linked to the production and capitalization of scientific knowledge are not overlooked.

Finally, this study is significant in helping us identify and understand the conflicts of interest and tensions that the *triple helix* model implies for universities. In analyzing the intended and unintended effects of policies encouraging the capitalization of academic scientific research, the overall impact of these activities on all segments of the university can be fully comprehended.

1.1.7 Overview of the Study

The first chapter of this study details the direction as well as the theoretical leaning of the entire work. Chapter one introduces the study in general terms by delineating some of the changes that have taken place in terms of academic knowledge production and capitalization as well as some key transformations in North American higher education. The chapter also detailed the research problem in both broad and specific terms. Having put the research problem into perspective, the work moves to conceptualize some of the study's key terminologies. The chapter also outlines the purpose of this study, the research questions, study objectives, and the significance of the study.

In chapter two, the study traces the development of the sociology of knowledge by noting that there is a blend of the convergence of epistemology and sociology that is traceable from Hegel to Marx. However, in terms of classical thoughts on the sociology of knowledge, the focus is on Karl Mannheim under whose direction the sociology of knowledge acquired a large impetus. The transformation in the scope of academic

knowledge production in both modern and post-modern traditions is also discussed. Chapter three outlines the empirical and theoretical dimension of knowledge production and capitalization. The focus is on the competing theoretical explanations for the changes in the regime of knowledge production represented under the rubric of the *New Production of Knowledge* and the *Triple Helix of University—Industry—Government Relations*.

In addition, the chapter addresses the developments of *triple helix* in Canada, the Canadian National System of Innovation, and ends with a critical look at the theoretical and methodological drawbacks of the conceptual framework of the study—the *triple helix* model. Chapter four is devoted to the methodological assumptions underpinning data collection, analysis and discussion. The study explores survey research methods to gather quantitative data and in-depth interviews to collect qualitative data, as well as, how data processing was done and the limitations of both the research methodologies and the study.

Chapter five, which is the first of the two analytical chapters, captures the quantitative element of the study. The analysis was done under themes relating to the production and capitalization of knowledge, transformations in academia, and the outcomes and perceptions of industry—university research collaboration. Chapter six, the second analytical chapter is devoted to the qualitative elements of the study. It captures the content analysis of common themes that emerged around the schematic questions used in the interview process. Chapter seven summarizes the entire study reinforcing its call for the understanding of the university as a ‘differentiated social system’ rather than a ‘unified whole.’ While conclusions were drawn from the study, the chapter seven also touches on possibilities for future research.

Chapter Two

2.1.0 The Theoretical and Empirical Transformations of Knowledge

In this study, transformations in the realm of scientific knowledge production and capitalization are surveyed. The overall project is built around the theoretical agenda proposed by the *triple helix* of university-industry-government relations. The *triple helix* interface considers the result of an interaction between functional and institutional dynamics in society. It recognizes this interaction as key to improving the settings for innovation in a science-based knowledge economy. As formulated, the *triple helix* model accounts for the multiple reciprocal relationships among institutional sectors at different points in the knowledge capitalization process (Etzkowitz and Leydesdorff, 1997). In spite of this, in any sociological study, the examination of issues must not only resonate with sociological dictums, but must also be embedded within certain theoretical perspectives.

Theory occupies an essential place in any sociological analysis. For Marx, the function of theory was to guide men in changing the world. For Mannheim, theory was to provide scientific guidance for action directed towards ‘planning for freedom’ (Zeitlin, 1997:383-4). However, as Castells has recently reminded us, theory is “a tool to understand the world, not an end for intellectual self-enjoyment” (1997:3). Thus, in attempting to comprehend the perceptions of academic scientists regarding the production

and capitalization of knowledge, some classical and contemporary theories in the sociology of knowledge are drawn upon not simply as intellectual cascades but, rather, as foundations upon which the overall project of knowledge production and capitalization are mapped. However, it must be stated that in this study, classical theory is not explored as an endless mantra, but blended with contemporary theories of sociology of science and knowledge that are relevant to the issues of knowledge capitalization. In the classical tradition, the works of such scholars as Hegel, Comte, Marx, Durkheim, and Merton are briefly discussed. The focus in terms of classical theory is on Karl Mannheim, under whose direction the sociology of knowledge developed and received immense interest. On the other hand, within the contemporary works emphasis is placed on such theorists as Habermas, Giddens, Bourdieu, and Lyotard.

2.2.0 Theoretical Developments in the Sociology of Knowledge

The sociology of knowledge has a blend of the convergence of epistemology and sociology that is traceable from Hegel to Marx. In the Hegelian tradition constituted by phenomenology, knowledge did not take the objective cognitive form it came to take under French social thought seen mostly in the works of Comte and Durkheim. In Hegel's work, knowledge is part of the self-constitution of society. The progressive forms it took are also part and parcel of the self-consciousness. This conceptualization is remarkably different from Comte and, in particular, Durkheim who conceived of knowledge as cultural models attached to social structures (Durkheim, 1960 and 1977).

Auguste Comte envisioned the evolution of society in terms of the development of forms of knowledge (Turner, 1998). Comte's sociology articulated via his 'law of the three stages' outlines a transition in knowledge from a *theological stage* where magico-

religious types of knowledge dominated, to a *metaphysical stage* characterized by rational and abstract knowledge such as the conceptions of sovereignty and law. The final *positivistic stage*, the society of Comte's own time was founded on experimental scientific knowledge. Comte thus saw social change in relation to the development and changes in societies' systems of knowledge (Turner, 1998).

For Marx, all human thought and consciousness develops out of real life, the actual social conditions that particular individuals share. In Marx's theory of ideology, a class's false *consciousness* of itself was an ideology. For him, "ideas, all forms of knowledge, and consciousness, are in some way interwoven with material activity" (Marx, 1970, cited in McCarthy, 1996:34). It must be noted that while Hegel saw knowledge and self-reflection as mutually intertwined, this conception seem to be obscured in Marx's critique. This, according to some critics, was the result of Marx's reduction of knowledge to ideology (Delanty, 2001).

Durkheim saw knowledge as a social construct, which has its meaning in the cultural system of society. Durkheim, unlike Comte did not see knowledge as the chief facet of modernity. The difference in their conception of knowledge is attributable to the fact that Durkheim tends to focus more on knowledge as a cognitive structure (Durkheim, 1977). Durkheim in a way did not intend this to represent an absolute distinction between knowledge and society to the point that all knowledge claims are relativistic (Schmaus, 1994). In spite of this, one can still feel a hint of the French positivistic tradition in Durkheim's (1960 and 1977) conception of social knowledge as based on the scrutiny of universal structures, which could be revealed by scientific knowledge. Although Durkheim's work did suggest a broader concept of knowledge, such as the Comtean one,

the sociology of knowledge in fact developed as a consequence of Karl Mannheim's work.

Mannheim was concerned with the social processes of ideology (Mannheim, 1953; Dant, 1991). In his formulations, knowledge was reduced to the world of ideas, especially ideologies associated with particular groups in society. Like Weber before him, and to an extent following his lead, Mannheim acknowledged the proposition that the significance of Marx's scheme lay in the hint that there is a parallel between the economic structure and society including its legal and political organization (Zeitlin, 1996). To Mannheim, even the world of our thought is affected by these relationships in that the "ideas that people hold vary with changing economic circumstances" because these ideas are "somehow connected with the social context in which they live" (Zeitlin, 1996:338). He was interested in 'meaning' since, for him, the most important relationship and interactions of humankind were meaningful and communicative acts. The foremost idea of his sociology of knowledge lay in his conceptualization that:

The greatest act of a sociologist involves his constant attempt to relate changes in mental attitudes to changes in social situations. The human mind does not operate in a vacuo; the most delicate change in the human spirit corresponds to similarly delicate changes in the situation in which the individual or a group finds itself, and, conversely, the minutest change in situations indicates that men, too, have undergone some changes (Mannheim, 1953:219).

As a result, he suggested that every cultural product and/or social event will reveal, if one explores intensely enough, three levels of meaning: the *objective*, the *expressive* and the *documentary* (Mannheim, 1953:219).

Mannheim derived from Hegel and Marx the conception of history as a structured and dynamic process. This required one to see "facts and events not as isolated phenomena and occurrences but in relation to the dominant social forces and trends and

to the whole social situation existing at any given moment” (Mannheim, 1953:214). He adopts his working hypothesis from Marx’s idea that the conditions of men’s social existence tend to determine their social consciousness in its full, conflictive, and dialectical sense (Mannheim, 1960). Like Marx, he protests the separation of thought from action. This he assumes would enable the sociological theory of knowledge to provide a scientific guidance for action that can be directed toward social change or as he calls it ‘planning for freedom’ (Zeitlin, 1996).

Mannheim believed that the total conception of ideology requires sociological analysis. He, therefore, proposes two formulations—the special and the general—to deal with this conceptualization. The *special* is the process whereby a group discovers the “situational determination” of its opponents’ ideas while remaining unaware that its own thought is being influenced by the social situation in which it finds itself. The *general* is employed when one “has the courage to subject not just the adversary’s point of view but all points of view, including his own, to the ideological analysis” (Mannheim, 1960:69). Thus for Mannheim, if the *general form* of the total conception is used in an investigation in a non-evaluative manner, that is to say, if judgements are temporarily suspended as to the truth or falsity of the ideas in question then one has a *sociology of knowledge* (Mannheim, 1960:69).

Robert Merton offered an alternative to Mannheim’s concern with ideas (Merton, 1970 and 1973). Merton condensed the sociology of knowledge to a more narrowly conceived empirical sociology of science within a broadly functionalist framework (Delanty, 2001). Merton indicated that Mannheim’s concern with ideas caused him to exclude science itself from the domain of the sociology of knowledge. In spite of this, it

must be noted that in the formative period of the sociology of knowledge, two quite separate recurrent themes that relate to the idea of continuity and change emerged.

First, there was the narrowly focused positivist-inclined tradition that concerned itself with the study of social groups—the professions and intellectuals—communication, public opinion and science. Second, there was quite separate approach associated with Peter Berger and Thomas Luckmann (1967). This tradition is rooted in the phenomenology of Alfred Schutz (1967). Here, the sociology of knowledge was radicalized through the rejection of a focus on the systems of knowledge—science, political ideologies and utopias—and systems of ideas in favour of a more hermeneutic turn to common knowledge (Schutz, 1967). This view asserted that knowledges are not merely the outcome of a social order but are themselves key forces in the creation and communication of a social order (Berger and Luckmann, 1967). It should be noted that this second proposition sought to replace the old classical theory of social determination with the idea that reality is socially constructed through knowledges and the vast numbers and kinds of symbolic systems (McCarthy, 1996).

In spite of this insight, sociological interest in knowledge for a very long time has repeatedly focused on the changing and relative character of knowledges. Consequently, the sociology of knowledge, notwithstanding its broad usage, has been mostly concerned with how social groups and forms of social organization contribute to the production and dissemination of knowledge. In addition to these themes, one can map three phases in the development of the sociology of science. Basically these three stages to a large degree are ‘internalist’ in nature (Cozzens and Gieryn, 1990). The first phase (the Mertonian—paradigm [1942] 1973), separated the institutions of science from other sub-systems of

society and explored for example, their “distinctive norms and reward structures” (Cozzens and Gieryn, 1990:1). The second symbolized by the specialty studies—characterized in classic research on radio astronomers—discovered the small-group structure of science and linked it to patterns of change in scientific theories and methods (Cozzens and Gieryn, 1990). Most recently social constructivism (Knorr-Cetina, 1999 and 1981; Latour and Woolgar, 1986; Lynch, 1985) became the third phase through the attempt by its advocates to go to the “heart of knowledge-production processes in laboratories and in ‘technical’ discourse to demonstrate the social nature of scientific knowledge itself” (Cozzens and Gieryn, 1990:1).

In spite of this, it is apparent that the closer one looks within science, the more society there is to be seen and it soon became evident to critical observers in the field of the sociology of science and knowledge that the internalist—externalist dichotomy was flawed since science is society (Cozzens and Gieryn, 1990). Thus, today, the sociology of knowledge has shifted focus to knowledge production and capitalization through university—industry—government relations. This in a major way has brought science back into society through the attempt to link knowledge with epistemology. Having traversed the broad terrain of classical sociology of science/knowledge, the next section begins with Habermas’ attempt to explain knowledge and human interest.

2.3.0 Epistemological Self-reflection and Empirical—Analytical Science

The sociology of knowledge brought together the convergence of epistemology and sociology that is traceable from Hegel to Marx. Jürgen Habermas revisited this convergence in his work *Knowledge and Human Interests* ([1968] 1972). This work was an attempt to grasp the “dissolution of epistemology which has left the philosophy of

science in its place” (McCarthy, 1978:53). It was indeed meant to “make one’s way over abandoned stages of reflection that are historically located in the movement of German social thought from Kant to Marx” (McCarthy, 1978:53). This form of immanent critique was intended by Habermas to re-open certain facets of reflection made silent by positivism’s pre-eminence. In spite of this, it is clear that Habermas’ main concern was the alteration of the relation between epistemological self-reflection and empirical—analytical science (McCarthy, 1978).

In the critical philosophy of Kant, science was comprehended as one type of potential knowledge. This formulation situated theoretical reason in an all-encompassing framework that integrated practical reason, reflective judgement and critical reflection (Habermas, 1972; McCarthy, 1978). Kant’s formulation failed to withstand the difficult pre-suppositions offered by Hegel’s transcendental philosophy. Since transcendental expression is not an absolute foundation but depends on something *a priori*, the intention of the ‘first philosophy’ that informed Kant’s critique was as a result illusory (Habermas, 1972; McCarthy, 1978). As such, the knowing subject in particular could not be “construed as an absolute origin outside and above history” (McCarthy, 1978:53-54).

Habermas agreed with the proposition that the knowing subject must be comprehended in its historical development. He, however, disagreed with the way Hegel developed this insight as a philosophy of absolute spirit. In Hegel’s account, instead of radicalizing epistemology, he rather abolished it (Habermas, 1972; McCarthy, 1978). This formation, according to Habermas, failed to critically comprehend experimental science as one kind of potential knowledge, and consequently, results in the dissolution of science as an absolute knowledge. Hegel’s original construction was, therefore, unable to

“withstand either the march of science or the rise of its positivistic mis-interpretation” (McCarthy, 1978:53-54).

For Habermas, Karl Marx represents another missed opportunity for radicalizing the epistemological project. Marx argued in his metacritique of Hegel that forms of consciousness arise, and are transformed, not idealistically through the self-movement of absolute spirit but through the development of productive forces and the struggle of social classes (Habermas, 1972; McCarthy, 1978). These forms are encoded representations of the self-reproduction of the species, a process that takes place under contingent material environments (Habermas, 1972; McCarthy, 1978). In Marx’s formulation, the subject of knowledge was neither an inspirational self-image nor an absolute spirit, but a personified “labouring subject whose capacities develop historically in the changing forms of the confrontation with nature” (McCarthy, 1978:54).

The above, thus, made the synthetic activity of the knowing subject that Kant disclosed a mere pale shadow of the “sensuous human activity” through which labouring subjects regularized their “material exchange process with nature and in so doing constitute a world” (McCarthy, 1978:54). Marx, therefore, separated the reconstruction of the self-formative process of species from its idealistic assumptions. This opens an avenue of reflection on the subject of knowledge that circumvents the individualistic and ahistorical limitations of Kant’s transcendental critique. As well, it moved beyond the idealist extremes of Hegel’s philosophy of identity (Habermas, 1972; McCarthy, 1978).

Though Marx turned Hegel on his head, like Kant, he failed to realize the potential for the radicalization of epistemology that his metacritique of Hegel had created. The setback in Marx’s work was that instead of grasping science epistemologically, he

claimed for his own work the mantle of a precise science by unveiling the “economic laws of motion of modern society” as “natural laws” (McCarthy, 1978:55). For that matter, the form in which it was left, like the work of Kant, could not sustain radical reflection against the attack of positivism. These in Habermas’ (1972) estimation are the ‘abandoned stages of reflection’ that he hopes to revive through his theory of cognitive interests.

Habermas’ central thesis is that the “specific view points from which we apprehend reality” and, indeed, the general cognitive strategies that guide logical inquiry have their “basis in the natural history of the human species” (McCarthy, 1978: 55). These, coupled with the essentials of the socio-cultural forms of life have permanently tied the reproduction of human life to the reproduction of the material basis of life. As a supplement to his central thesis, Habermas (1972) posits three specific theses *technical interest*, *practical interest*, and *emancipatory interest*, to deal with the history of the confrontation with nature that has, from epistemological standpoint, been a learning process.

For Habermas (1972), technical and practical interests are not simply sources of distortion to knowledge that must be eliminated for an ideal and objective orientation to the truth to appear. On the contrary, he holds that knowledge is formed only on the basis of interests. As such, what is crucial for him is not the elimination of interest, but analysis of the knowledge forming interests at work in any specific context (Habermas, 1972; McCarthy, 1978; Turner, 1998). This leads us to his broader concerns with communication through his explication of the structural transformation of the public sphere.

2.3.1 Structural Transformation: The State, Society and Industry

Habermas traced the evolution and dissolution of what he termed the public sphere¹ in his first major work, *The Structural Transformation of the Public Sphere* ([1970] 1991). To Habermas, a portion of the public sphere comes alive in every conversation in which private individuals assemble to form a public body. In this realm, “access is guaranteed to all citizens” (Habermas, 1974:49). The growth of a distinctive orientation to politically significant but unrestricted communication is traceable to 18th century Europe. In his estimation, this public sphere was one in which “disinterested argument about the public good was distinctively valued” (Calhoun, 2002:2). In the public sphere that Habermas demarcated, openness and critical-rational discourse were simultaneously important with more of each apparently marking an advance in democracy. However, openness and critical-rational discourse proved to be in tension as the public sphere expanded in scale. This led not only to the debasing of the quality of the discourse, but also made the public sphere more “vulnerable to mass opinion management through advertising and emotional appeals” (Calhoun, 2002:2-3).

However, it must be noted that Habermas’ focus was on the bourgeois public sphere. Although the bourgeois public sphere emerged in the tensioned-charged field between state and society, it did so in such a way that it still remained part of the private realm (Habermas, 1991). As such, the fundamental separation of the sphere of state and society initially referred merely to the disengagement of elements of social reproduction and political power. However, with the growth of a market economy emerged the sphere

¹ By public sphere, Habermas meant a realm of our social life in which something approaching public opinion can be formed (Habermas J, 1974).

of the “social,” which broke the fetters of domination based on landed estate, and necessitated forms of administration invested with state authority. Due to the manner in which it was linked to market exchange, production was disengaged from its connection with functions of public authority, thereby, releasing public administration from production tasks (Habermas, 1991:141). However, state intervention in the sphere of society, in the long run, found its counterpart in the transfer of public functions to corporate bodies.

Similarly, the opposite process of a substitution of state authority by the power of society was connected to the extension of public authority over sectors of the private realm. It was only this dialectic of a progressive “societalization” of the state, simultaneous with an increasing “stateification” of society that gradually destroyed the basis of the bourgeois public sphere (Habermas, 1991:142). As it were, a repoliticized social sphere emerged to which the distinction between “public” and “private” could not be usefully applied. Consequently, the demise of the public sphere, as revealed by its altered political functions had its basis in the structural transformation of the relationship between the public sphere and the private realm (Habermas, 1991).

In fact, Habermas’ critics have argued that the public sphere as explicated by him is overly exaggerated. They point out that he idealizes the earlier bourgeois public sphere by presenting it as a forum of rational discussion and debate when in fact certain groups were clearly excluded, thus limiting participation (Fraser, 1992; Eley, 1992; Ryan, 1992; Kellner, 2000). As Nancy Fraser has noted, from revisionist history and indeed Habermas’ own account, we know that the bourgeois public’s claim to full accessibility was never ever close to being realized. Indeed, women of all classes and ethnicities were

excluded from official political participation on the basis of gender status, while plebeian men were formally excluded by property qualifications (Frazer, 1992). It became clear that not only did Habermas omit these crucial developments, but also, he marks the “decline of the public sphere precisely at the moment when women were beginning to get political power and become actors” (Ryan, 1992:259; Kellner, 2000:267). More so, Habermas was thought to have exaggerated the emancipatory potential inherent in his idealized bourgeois public sphere (Calhoun, 1992).

In spite of the criticisms, Habermas’ analysis of the emergence of the various elements of the public sphere, particularly, its social and private spheres are very important for the discussion of academic knowledge production and capitalization. The conundrum posed by Habermas’ analysis of the public sphere was how to reclaim the kind of communication that underpins the notion of reasoned collective choice by informed citizens without confining that to narrow elites (Calhoun, 2002). This enigma is quite relevant to our understanding of the transformations occurring in the conduct of scientific research in this era of accelerating globalization. However, before we move to the crust of that debate, there is the need to understand Habermas’ efforts to position the modern university as a mechanism of society’s self-understanding.

2.3.2 The University as a Mechanism of Society’s Self-understanding

Habermas re-opened the old German question of the idea of the university by attacking those who try to reduce the university to either a site of the production of instrumental knowledge or to the culture of humanism (Habermas, 1970). According to Habermas the university was not defined by either organized or liberal modernity. In his

view, the task of the university was to provide a political education through the shaping of a political consciousness among its students. As he puts it:

For too long, the consciousness that took place in German universities was apolitical. It was a singular mixture of inwardness, deriving from the culture of humanism, and of loyalty to state authority...This process reproduced the mentality of a university-trained professional stratum for which society still intended a relatively uniform status...As we know, the academic stratum, shaped by a uniform mentality, has dissolved in connection with long-term structural changes in society (Habermas, 1970:3).

Habermas emphasized the role of the university as an interpreter of the self-understanding of society rather than the mere transmitter of its heritage in an unfiltered manner. This task is discernible from the university's task of transmitting, interpreting, and developing the cultural tradition of society (Habermas, 1970). Essential to the mission of significantly transforming society in Habermas' assessment is the need for a critical reflection by the university on its own pre-suppositions and the necessity to embark on radical internal democratization. The problem as Habermas saw it was that the "university was inserted into democratic society with a certain political extension of its traditional understanding, *but otherwise just as it was*" (1970: 5).

According to Habermas (1992), what is peculiar to the university is that it is a 'bundle institution'. Universities are still rooted in the *life-world* through the bundling of functions, such as the research process, general education, cultural self understanding, the formation of public opinion, and the training of future specialists (Habermas, 1992:107). Habermas thus held that as long as this complex has not been completely torn apart, "the idea of the university cannot be completely dead" (Habermas, 1992:107-8). Filled with optimism, he indicated that "a new life can be breathed into the idea of the university" but this to him is only possible from "outside its walls" (Habermas, 1992:108). While the

exact meaning of this statement may be subject to interpretation, it still raises a lot of questions that the remainder of this study attempts to unpack. However, to explore the relationship between socio-economic and political domains of knowledge production and capitalization demands an understanding of sociological attempts to overcome the dualism problematic.

2.4.0 Structure and Agency: Knowledge Production and Capitalization

The idea that social structures are actively produced and changed by human agents who in turn draw on these transformed structures lies at the heart of Giddens structuration theory. However, before one proceeds, it must be stated that as a critique of science, Giddens' structuration theory should be viewed as a bundle of 'sensitizing' concepts that are discursively linked (Layder, 1994). Structuration theory is Giddens' attempt at offering a sufficient theoretical account of action which does not obliterate the role of either structure or agency (Baber, 1991). According to Giddens, "structural properties of social systems are both the medium as well as the outcome of the practices, which they recursively organize" (1984:25). This idea in structuration theory is known as the 'duality of structure'. The duality of structure implies that structure is not external to humans but caught up in their behaviour and knowledgeability (Hagendijk, 1990). Thus for Giddens, instead of a dualism, the social scientist should rather think of one structure which has a twin nature (Layder, 1994).

The duality of structure is the vehicle through which Giddens seeks to resolve the micro-macro dualism in sociology. It enables Giddens to tackle the twin issues of social production and social reproduction. For Giddens, human beings create meaning and

social reality from within social settings and, therefore, social forms such as institutions and structures have no existence apart from the activities they embody (Layder, 1994). In his estimation, interpretative sociologists have overly focused on the problem of social production at the expense of social reproduction. As a result, they tend to view the social actor as a product of the constraining influences of social structure (Layder, 1994). Giddens assumed that structure could be conceptualized as *rules*² and *resources*³ that actors use in interaction contexts. These rules and resources, in addition, extend across space and over time (Turner, 1998). Giddens conceives *rule* as a methodology or technique that actors know about, often only implicitly. However, it provides a relevant formula for action. On the other hand, a *resource* is the material equipment and the organizational ability needed to act in situations (Turner, 1998). The thrust of Giddens' argument is that rules are part of actors' knowledgeability.

As such, undertaking the project of understanding the perception of academic scientists of the production and capitalization of knowledge demands an excursion into the structuration of social systems. In Giddens' estimation, rules and resources are not only drawn upon by actors in the production of interaction, but in so doing, are also reconstituted through such interactions. This is because institutions do not just work 'behind the backs' of the social actors who produce and reproduce them. Thus one needs to understand knowledge in terms of both practical and discursive consciousness (Grabb, 2002). The capitalization of scientific research likes the "structural properties of social systems do not exist outside of action but are chronically implicated in its production and reproduction" (Giddens, 1984:374). The constitution of agents and structures are not two

² Rules are generalizable procedures that actors understand and use in various instances (Giddens, A. 1984).

³ Resources are facilities that actors use to get things done (Giddens, A. 1984).

independently given sets of phenomena—a dualism, but instead represent a duality (Giddens, 1984:25). For that matter, though scientists are agents, they are not isolated individuals. As agents, they operate within and based on changing structures that surround them. It is, therefore, necessary to understand the linkages between agency and structure when seeking an understanding of the transformations of scientific research in the larger context of university-industry-government relations. This demands more than a mere exploration of the perceptions of academic scientists of the production and capitalization of knowledge as individual actors. It also requires one to look at the university as a social system, which in this context denotes a ‘differentiated’ social system.

In Giddens’ structuration theory, the basic domain of the study of the social sciences is “neither the experience of the individual actor, nor the existence of any form of societal totality, but social practices ordered across space and time” (1984:2). This is because university-based research innovators as structures referred not only to rules that are implicated in the production and reproduction of social systems, but also, to resources (Giddens, 1984). For, even if there are well-understood methodologies and formulas, that is, rules to guide action, there must also be the capacity to perform tasks. Such capacity requires resources, or the material equipment and the organizational ability to act in situations (Turner, 1998:493).

Giddens’ work has been criticized on the ground that it fails to get at the social structures that underlie the social world through its focus on social practices (Craib, 1992:178). Also, Giddens’ attempts at theoretical synthesis do not engage so well with the intricacies of the social world. This complexity requires not one single synthetic

theory, but a “range of theories that might be quite incompatible” (Craib, 1992:178). In spite of this, Giddens has indeed put together a synthesis that draw our attention to the fact that sociological analysis based on such dualisms as structure and agency are only restricted entities that partially radiate social reality. The task then is to look at them as interlocking variables or in Giddens terminology as a duality. The next section details the arguments of another theorist who offers a challenging account of the institution of knowledge in modern societies.

2.4.1 Habitus, Practice and Field: Academic Power and Knowledge

Another contemporary sociologist who was energized by the desire to overcome the “absurd opposition between individual and society” by reintroducing agency into social analysis is Pierre Bourdieu (1990:31). Bourdieu (1990) preferred a structuralist position that does not lose sight of agency. As such, he tended to focus on the dialectical relationship between objective structures and subjective phenomena. For Bourdieu, people are endowed with a series of internalised schemes—*habitus*. Through these internalised schemes, people produce, perceive, understand, appreciate and evaluate the social world (Ritzer, 2000). In spite of this, it is *practice* that mediates between *habitus* and the social world. On the one hand, it is through “*practice* that the *habitus* is created and on the other, it is as a result of *practice* that the social world is created” (Ritzer, 2000:530). This dialectic enables Bourdieu (1990) to escape from having to choose between subjectivism and objectivism.

In addition to *habitus* and *practice* another important concept in Bourdieu’s analysis is *field*. Bourdieu conceptualizes the *field* in relational rather than structural terms. As such, *field* denotes a network of relations among the objective positions within

it (Bourdieu and Wacquant, 1992). It must be stressed that Bourdieu (1990) recognized semi-autonomous *fields* such as artistic, religious, and higher education in the social world, all of which have their own specific logics. Besides, all of them generate among the actors a belief about the things that are at stake in a *field*. The *field* for Bourdieu is an arena of struggles, a type of “competitive marketplace in which various kinds of capital—economic, cultural, social and symbolic—are employed and deployed” (Ritzer, 2000:530). Based on this analysis, Bourdieu saw education as a *field* in which the broader conflicts and sources of inequality in society are manifested.

In terms of knowledge and higher education, Bourdieu (1984) conceived of the university as a set of social practices, which served as an intermediary of cultural catalogue that allows power to flow within and across institutional settings. This account is relatively different from other key notions of the university. For instance, Parsonian theory of the university was based on the suggestion that there is a functional link between knowledge and citizenship (Parsons, 1974). Habermas (1972), on his part, posited that knowledge is deep-rooted in socially produced interests, which if articulated in communicative terms, conferred an emancipatory purpose on the university. Bourdieu (1984), however, questioned these kinds of interconnectivity between the university and society. Borrowing from Michel Foucault (1980), the idea that knowledge is power, Bourdieu (1984) argued that knowledge “is not primarily emancipatory but socially located in contexts of power which are in essence...cognitive systems in which symbolic capital circulates” (Delanty, 2001: 89). He offered quite a different approach to the university by describing it as a “self-preserving institution in which different kinds of power are produced, circulated and reproduced” (Bourdieu, 1984: 11).

Bourdieu's (1984) concern was directed at unravelling different power contexts to make it possible for knowledge to be reflexively reconstituted. As such, his sociology of knowledge, to a degree, proffers a significant outlook on the cognitive structures that shape and influence the production and dissemination of knowledge in society (Bourdieu, 1984). He demonstrates the fact that the internal constitution of power within the university refracts the way power is constituted in the larger society. As he notes:

The university field is, like any other field, the locus of a struggle to determine the conditions and the criteria of legitimate membership and legitimate hierarchy, that is, to determine which properties are pertinent, effective and liable to function as capital so as to generate the specific profits guaranteed by the field (Bourdieu, 1984:11).

This was meant to show how dialectically, the structure of the academic field through miscellany and indoctrination contributes to the reproduction of the field of power in the larger society (Ritzer, 2000). For instance, the French academy is divided between the dominant fields of law and medicine and the subordinate fields of science and the arts to a lesser extent. This division parallels the field of power in which those "with social competence are temporally dominant and those with scientific competence are socially subordinate" (Ritzer, 2000:540; Bourdieu, 1984). There is in his view, a struggle between three types of symbolic capital that is fought in the university. These are academic power, scientific power and intellectual power. As he puts it, in the university:

The different sets of individuals (more or less constituted into groups) who are defined by these different criteria have a vested interest in them. Thus in proffering their own claim to constitute them as legitimate properties, as specific capital, they are working to modify the laws of formation of the prices characteristic of the university market (Bourdieu, 1984:11).

However, the matter is greatly complicated by the fact that academia is both a social and cultural hierarchy ruled by cultural capital derived from either scientific authority or

intellectual renown. In the cultural domain, the hierarchy of the academic disciplines is reversed: science is on top, with law and medicine ranking lower (Bourdieu, 1984).

While Bourdieu sought to bridge the structuralism and constructivism gap, there is bias in his work in the direction of structuralism. Bourdieu's constructivism ignored subjectivity and intentionality although he included within his sociology the way people, on the basis of their position in social space, perceived and constructed the social world. Similarly, the nature of habitus in his view changes with altered historical circumstances (Ritzer, 2000). These limitations aside, he has contributed greatly to our understanding of the academic landscape in terms of knowledge and higher education. As such, the next section of the study will focus on what is generally referred to in the sociological literature as post-modern science. Post-modernism in the most general sense concerns both a deconstruction and reconstruction of the cultural assumptions of modernity. This school of thought will largely be represented by the work of Jean-François Lyotard.

2.5.0 The Post-modern Twist: From Consensus to Instabilities in Knowledge

Knowledge production and utilization has undergone many transformations. These changes are affecting the university as the bastion of knowledge. The role of the university of course goes beyond the narrow sphere of knowledge production. In the realm of politics and the structure of the modern nation—state, the university is a highly regarded actor. However, as knowledge has become the primary source of development and international competitiveness, universities have broadly been recognised as agents of socio-economic growth and development (World Bank, 1998). The processes of globalization in economic organization, ICTs, and policy management systems have

challenged the sovereignty of the nation—state (Delanty, 2001). Faced with these challenges, the nation—state responded with different kinds of strategies that included a move away from being the exclusive financier of academic knowledge production. This shift has partly resulted in the emergence of multiple knowledge producers (Gibbons et al. 1994).

In addition, the emergence of new links between society and knowledge has also affected the landscape of knowledge production. As new innovations create both scientific and social uncertainty, knowledge is rapidly becoming a new site of conflict in society. Based on the ever-increasing production, dissemination and utilization of knowledge, some sociologists have labelled modern society a ‘knowledge society’ (Stehr, 1994). In other words, knowledge is no longer a meta-narrative (Lyotard, 1984) but has entered the production process and is increasingly being generated in the context of application (Gibbons et al. 1994). However, since the epistemic condition of modernity is an integral part of the university’s ethos, knowledge was under the aegis of the university, given both a “consecrating function in society and autonomy from society” (Delanty, 2001:133). It is, therefore, to be expected that the advent of post-modern attacks on the ideals of modernity and its knowledge structures would be directed towards the university, the citadel of knowledge, and the advocate of the goals and ideals of modernity (Delanty, 2001).

Jean-François Lyotard’s ultimate vision of science and knowledge in his work, *The Post-modern Condition: A Report on Knowledge* (1984) was a search for ‘instabilities’ rather than consensus. This was meant to be the practice of ‘paralogism’⁴

⁴ Paralogism is an exercise in which the point is not to reach an agreement but to undermine from within, the very framework in which the previous ‘normal science’ had been conducted (Lyotard, J-F. 1984: xix).

since he believed that the old code that the acquisition of knowledge cannot be distinguished from the training (*Bildung*) of minds, or even of individuals has become obsolete and will continue along that path. His main claim is built around the argument that knowledge is productive, not emancipatory or autonomous. For him, knowledge is, and will continue to be produced for its economic value (Lyotard, 1984).

Focusing his attention on the university, Lyotard (1984) lays out what will turn out to be an essential bridge connecting sociological theories of the post-industrial society with post-structuralism. In fact, post-structuralism has broken ranks with the modernist stance that knowledge is culturally universalistic, independent of society, and politically emancipatory (Lyotard, 1984). Therefore, in the emerging post-industrial society, he saw the sociological reality of the post-structuralist thesis. In this type of post-modern society, a unifying grand narrative is absent. The existing post-modern condition is one of fragmentation with the role of knowledge at the centre of this dissolution (Lyotard, 1984).

In modernity, knowledge to a degree was independent of the social order. This to most observers made it possible to look at knowledge as holding the prospect for political emancipation (Delanty, 2001). In fact, the core principle of the Enlightenment was the belief that knowledge could unshackle people from the fetters of tradition. This vision of knowledge was the source of many ideas of modernity. In these worldviews, knowledge contained a metaphysical principle that was in tension with the prevailing social order. This principle was an abstract one and could only be grasped through a radical transformation of reality (Delanty, 2001). In fact, to a degree, all the great Enlightenment thinkers, from Hegel to Marx, held to the idea of the liberating power of knowledge. Hegel, for instance, saw human history as a progressive unfolding of narratives of self-

consciousness. For Comte, the Enlightenment period was dominated by a ‘metaphysical’ conception of knowledge which would in time give way to the stage of positivism once its abstract principles were realized. For Marx, once a new narrative of class consciousness was created, human pre-history would come to a close (Delanty, 2001:134).

It must be stressed that the perception of these classical theorists was that the power of knowledge resided in its capacity to offer a unifying narrative. This, if politically planned, could lay the foundations of a new kind of society (Delanty, 2001). In Lyotard’s terms, Hegel, Comte and Marx held a notion of narrative as metaphysical which transcended reality. As such, there is an inherent assumption that this narrative contained a promise of transforming reality if appropriate political mechanism could be found (Lyotard, 1984). These meta-narrative visions of knowledge according to Lyotard have been rendered irrelevant by the post-modern condition. As a result, knowledge today is no longer abstract, metaphysical and emancipatory.

Consequently, since post-industrial society is based on knowledge, the implication is that we are “living in an information society which has fragmented knowledge by commodifying and instrumentalizing it”. For that matter, “knowledge has lost the promise of emancipation” (Delanty, 2001:134). Accordingly, the alteration of knowledge into information in post-modernism has led to the disappearance of the integrating power of narrative in the midst of fragmentation. For the university, this has far-reaching repercussions in that the fragmentation of knowledge means the loss of autonomous space that universities have occupied for several decades. It is clear that Lyotard’s attitude towards the post-modern condition is one of ambivalence (Lyotard, 1984). For him, the university, an institution of modernity on the one hand, has largely become

irrelevant to the political and cultural demands of the post-modern condition (Lyotard, 1984). On the other hand, the post-modern condition articulates a new kind of politics of plurality whereby political struggles occur on many different levels and cannot be concentrated in any one particular struggle, such as class struggle (Delanty, 2001).

Lyotard (1984) did not, however, see the university as central to the politics of plurality or of class struggle. The university, in his view is based on the principle of unity, which stems from the idea that varied types of knowledge and practices can be fused under a particular institution. It is thus deducible that Lyotard's political orientation mirrors his stance on the university. His political orientation can be interpreted as a post-modern version of Marxism. In other words, it is Marx read through the eyes of Nietzsche in that the "disintegration of the cognitive and institutional structures of modernity has been completed and radical politics must accept this" (Delanty, 2001:134). This was a declaration of the end of the university as a result of the fact that the university was too much implicated in the control of the state and society. Consequently, Lyotard (1984) dismisses the entire neo-humanist tradition that comes to life in Humboldt's vision of the incorporation of teaching and research. He imagined that in the post-modern condition the university, along with the capitalist state, would wither away (Lyotard, 1984).

In fact, the reality of the post-modern condition in Lyotard's view is the dominance of the performativity principle. This is not so much distinct from the new production of knowledge (Gibbons et al. 1994) thesis, but here it is the use of knowledge that legitimates its production. To Lyotard (1984), the post-modern condition is a time of de-legitimation with knowledge de-legitimation one of the most pervasive features of authority de-legitimation. Thus, the predominance of the performance criterion in the

post-modern condition is the result of the de-legitimation of knowledge (Lyotard, 1984). One aspect of the predominance of the performance criterion is the de-personalization of knowledge. As he puts it, “a professor is no more competent than memory bank networks in transmitting established knowledge, no more competent than interdisciplinary teams in imagining new moves or new games” (Lyotard, 1984:53). In this view, the university can neither be the site of communication, as Habermas (1984 and 1987) saw it, nor can it be the site of a different and more reflexive kind of symbolic capital as in Bourdieu (1984). This is because the modern university has become a modernist attempt to construct totalizing narratives (Lyotard, 1984).

It is clear that Lyotard (1984) had pronounced the death of the university. However, in the process of doing so he had failed to recognise the fact that there are different ideas of the university apart from the Humboldtian vision. As Bauman (1997) has indicated, the plurality and the multivocality of universities are liberating and could be the basis of new dialogues. Indeed Lyotard has failed to recognise that in the post-modern condition, there is greater diversity of universities and all sorts of knowledge. This is imperative because on the one hand, it demonstrates the difference between knowledge and information, and on the other, the difference between teaching and research. Another effort directed at understanding the changing contexts of science and society is the approach garnered under the rubric of a post-normal science. The next section explores some of its contours.

2.5.1 The Changing Context of Science: Uncertainty and Value-Conflict

Another approach that sought to enhance our understanding of the changing contexts of science is a variety of articles under the umbrella of a *post-normal science*⁵. As it has so far developed, post-normal science is more an “insight rather than a theory” (Ravetz and Funtowicz, 1999:642). Post-normal science emphasizes the need for science to join the polity through extended peer communities with their ‘extended facts’ (Ravetz and Funtowicz, 1994:569). It seeks to provide a philosophical foundation by bringing back the contradiction between hegemonic reductionism and fragmented relativism, which accordingly exemplifies the post-modern condition (Ravetz and Funtowicz, 1994). Through this mechanism, post-normal science, it is believed, will legitimate the introduction of a plurality of knowledge into policy discussions. As Ravetz and Funtowicz notes:

The threats of unknown, irreversible and potentially dangerous developments in the technologies of information, notably biological but also electronic, have finally brought home the message that science must join the polity...the reduction of complex whole systems to their simple atomic elements, is finally becoming understood as the production of the tools of technological power without the means of societal control (1999:641).

It is clear that there is the belief that the conventional claims to truth and the virtue made for science can no longer shield it from the checks and balances that are applied to all other institutions of society. The understanding is that no substantial area of scientific progress is impervious to the problems of uncertainty and value conflict (Ravetz and Funtowicz, 1999). It is through this gauge that science, to a degree, has become post-normal.

⁵ Post-Normal Science refers to the appreciation of diversity, which is not at all the same as relativism and that can lead to a new practice of science in emergent complex systems (Ravetz and Funtowicz, 1999:577).

As an extension of the systems theory perspective, post-normal science represents a significant effort to come to terms with the repercussions of concepts, such as, the ability to “control” and ‘manage’ scientific practice (Tognetti, 1999:691). Tognetti estimates that post-normal science can be regarded as an approach for dealing with concerns in which there are “high stakes and uncertainty...in which decisions are urgent” (1999:691). This contrasts with “normal” science which is considered to be an extension of the laboratory. Normal science cannot deal with multifaceted global problems (Tognetti, 1999). It should be noted that there have been many attempts to achieve more sophisticated versions of reductionist science. The attempt at a point in time involves systems theory. However, according to Funtowicz and Ravetz (1999), the recent growth in the appreciation of post-normal science indicates a change in attitude and direction. They believe that this new attitude will make possible a resolution of the fragmentation of knowledge that has resulted from the collapse of the hegemony of the old reductionist conception of science.

Key to the analysis using the post-normal science approach is the concept of *contradiction*, usually drawn upon as part of *dialectics*. In the context in which it is often used, contradiction stresses the “co-existence of antagonistic forces, and provides a perspective which prevents oversimplified analysis of situations and problems” (Funtowicz and Ravetz, 1994:572). This, as the authors suggest, makes it impossible for one to “envisage a beneficial progress without looking for its costs...or the achievement of good without some production of evil” (Funtowicz and Ravetz, 1994:572).

Based on these developments, it is sufficient for one to conclude that post-normal science adopts what can be characterized as a co-evolutionary approach to economic

development. The objective, as its proponents have noted, is to look for “elements that provide mutual reinforcement” (Tognetti, 1999:699). Through the idea of co-evolution, post-normal science is linked to the *triple helix*. However, their basic difference is that the process by which the concept of co-evolution is integrated into post-normal science aligns it with the way the concept is understood in evolutionary economics. As such, while evolutionary economics focuses on “the co-evolution of technological trajectories and selection of environments, the *triple helix* endogenizes the knowledge infrastructure of society as a next-order regime” (Etzkowitz and Leydesdorff, 1997:157).

In addition, post-normal science focuses on political dimensions of specific practice, though it claims that its focus should not be reduced to politics but to an extended public participation in decision-making on science-related issues (Ravetz and Funtowicz, 1999). The *triple helix*, however, is complex enough to take on board various species of chaotic behaviour. Since the *triple helix* operates in terms of translations among specific communications, it adapts to highly selective transformations of institutions (Etzkowitz and Leydesdorff, 1997). With this in mind, the next section introduces us to the debate about the transformation of academic scientific research and the controversy that such entrepreneurial activities are generating in terms of the Mertonian norms of science.

2.6.0 Re-drawing Research Boundaries and the Controversy over the Norms of Science

The university is a medieval concept envisaged in its formative years as an institution for the production, preservation and transmission of culture (Etzkowitz, 2002). Embedded in this role is resistance and acquiescence to social forces of change. However,

in its seminal years, the university's existence hinged upon the performance of this very first mission. Though changes were occurring within the domain of the university, they were occurring at a very slow pace. As such, the incorporation of research into the agenda of the university constituted the first major shift in its ideology. This paradigmatic change has since expanded towards the redrawing of the boundaries between basic and applied science (Kaghan, 2001). An outcome of this shift is the "shortening of the time span between discovery and utilization, and increased reliance of industry on knowledge originated in academic institutions" (Etzkowitz, Webster and Healey, 1998:2). In the pursuit of these objectives, an entrepreneurial university emerges, generating so much debate about the relevance and place of the Mertonian norms of science.

The concern is that efforts directed at capturing the economic outcomes of campus-based research are impacting negatively on teaching and the conduct of what has been termed 'curiosity-driven' research. This is not to overlook the fact that the introduction of formal research into the agenda of universities was itself fraught with controversy. In sociology, it is the work of Merton and his students that forcefully brought issues of science and technology to the fore. Merton (1973), in his classic formulation of the norms of science, treated science as a social institution, which has functional prerequisites—*universalism*, *disinterestedness*, *organized skepticism* and *communalism*. In Mertonian terms these norms collectively constituted the "ethos of science" (1973: 270).

The *universalism* ethos is built on the expectation that a scientist's rank and status within a definite scientific community should not sway the judgement of particular knowledge claims. This is understood to mean that "truth claims, whatever their source,

are to be subjected to pre-established impersonal criteria: consonant with previously confirmed knowledge” (1973:270). However, since “objectivity precluded particularism” (Merton, 1973:270), knowledge claims in the scientific realm must be rooted in some impersonal and universalistic criteria. The ethos of *disinterestedness* is closely associated with that of universalism. This ethos is meant to guarantee impartiality in the appraisal of knowledge claims. At the same time, *organized skepticism* ensures that knowledge claims are accepted not on the basis of the rank or stature of a particular scientist but on the basis of scrutiny through established standards and measures. This is to guarantee that logical regularity and empirical precision are the only criteria for accepting what counts as scientific knowledge. Finally, the ethos of *communalism* refers to the exchange of knowledge within a scientific community. This is crucial because without it, other scientists cannot subject knowledge claims to critical scrutiny.

However, even though ideal-types are meant to be heuristic devices that catalogues a field of inquiry and identifies the primary areas of consensus and contention (Held and McGrew, 2003); this seems not to be the case with the norms of science. To a certain extent, Merton was conscious of the fact that, in actual practice, the ethos of science may not be adhered to by all scientists. In spite of this, he presented his formulation as a Weberian ideal-type in order to set up the normative features that are critical for the development of scientific knowledge (Baber, 2000). However, in the debates on the consequences of university—industry—government relations, whether the Mertonian norms of science are perceived as ideal-types or not, entrepreneurial academic activities are interpreted as being at odds with the letter and spirit of Merton’s scientific ethos.

However, as if in anticipation of current changes in the role of the university, Mitroff (1974) while pursuing Merton's notion of sociological ambivalence, proposed that scientists are guided by both norms and counter-norms, which generate ambiguity. Thus the norm of *communalism*, which enjoins a scientist to make public his or her work because it should become the shared property of the scientific community is inconsistent with a norm that regards scientific results "as private property, at least until one has derived sufficient career benefit from them" (Hackett, 2001:103). In fact, the notion of sociological ambivalence was clearly demonstrated when Merton (1957) stated that the primary motivation of university scientists is recognition within the scientific community. This to him comes from publications in peer-reviewed journals, presentations at prestigious conferences, and through the successful application and award of federal research grants. He indicated that faculty members may also be motivated by personal financial gain and/or a desire to secure additional funding for graduate students and laboratory equipment (Merton, 1957).

It is clear then that norms have ensuing counter-norms, which generates ambiguity. As Gibbons et al. (1994:22) have noted:

Science does not stand outside of society dispensing its gifts of knowledge and wisdom; neither is it an autonomous enclave that is now being crushed under the weight of narrowly commercial or political interests. On the contrary, science has always both shaped and been shaped by society in a process that is complex as it is variegated; it is not static but dynamic.

Therefore, the norms of science, which customarily denounce profit-making motives, are beginning to change to allow for this kind of entrepreneurship (Etzkowitz, 1998). The onus is thus upon scientists to reconcile these incompatible principles of conduct (Hackett, 2001). As asserted by Kleinman and Vallas (2001), much of the debate over the commercialization of science stems from the fear that several of Merton's norms,

especially *communalism, disinterestedness, and organized scepticism*, are in danger of being swept aside by the increasing desire of the scientific community to take economic advantage of their research. Thus as current debates make it apparent that ownership concerns threaten the free flow of information and research materials or are defining certain approaches as more rewarding than others, the scientist will probably experience declining autonomy or control over decisions about the nature of his research (Kleinman and Vallas, 2001).

In fact the issue of scientific autonomy transcends academic boundaries. In policy discussions, analysts make wide-ranging claims about scientists' autonomy. As such, the media hype of assorted university—industry relations in the biotechnology-related fields in the 1980s were based on “assumptions about the correctness or reality of these traditional notions of scientist-autonomy” (Kleinman and Vallas, 2001: 457). In the United States, for instance, critics of university-industry relations who regularly lament the spread of market constraints on the conduct of academic science, more often than not, neglect institutional impediments that in the past were pervasive. Indeed one does not need to be a sociological historian to recognize that in most instances the pervasive influence on the academia has typically emanated from the state rather than corporate organizations (Kleinman and Vallas, 2001).

However, the pressure today stems from the ongoing interaction between the three institutional spheres of knowledge production, university—industry—government. One outcome of this continuous but persistent interaction is a mounting pressure on universities to become isomorphic with their corporate collaborators (Kleinman and Vallas, 2001). Thus, it is not only because of direct economic links to corporate

organizations, but also, subtle systemic influences. As such, academic organizations are increasingly adopting practices that were formally specific only in the corporate domain (Kleinman and Vallas, 2001). Based on these reciprocal transformations, knowledge-intensive corporations are also adopting more collegial forms of organizational control that are customarily associated with academic environments (Kleinman and Vallas, 2001).

Although, historical accounts of the US research university suggest that the autonomous capacity of academic researchers in defining and setting priorities has varied over time, it is also true that cases of relatively high levels of faculty autonomy are rather few in this history. For instance, in the 1920s and 1930s, when the US research university was in its infancy, support came largely from philanthropic foundations and private individuals (Geiger, 1986; Kleinman and Vallas, 2001). In spite of this, the concerns that motivated early policy debates and scholarly research have not faded. Hence, arguments premised on the notion that there was once a remote ivory tower only serve to bolster a myth rather than shed any light on a multifaceted process (Kleinman and Vallas, 2001).

In fact, during the period mapped out by Geiger (1986) for US research universities, the foundations and private individual funding sources were not disinterested charities. Their support often affected the choice of research topics and the approaches taken by investigators (Kleinman and Vallas, 2001). Robert Kohler (1990) for instance, noted that getting funding from the Rockefeller foundation was contingent upon accepting an approach to research problems determined by science managers with their own agendas rather than an extended scientific peer community. It is clear that the Mertonian norms of science are meant as guides rather than rules written on stones. They are subject to challenges as structural and institutional forces impinged upon the

university as a social institution to adjust and adapt to these socio-economic and political forces of change. With the transformation of the Mertonian norms of science in mind, the focus is to consider the changing global trends in higher education.

2.7.0 Globalization, Universities and the Production of Scientific Knowledge

The drastic reconfiguration of time and space (Giddens, 1990; Harvey, 1989) by the advances in ICTs has rapidly transformed the world of academia, as we know it. These significant transformations have had a considerable effect on public universities in terms of attempts to embrace the values of the marketplace. In the literature on globalization, the rationalization of the process by which space contracts and time collapses varies. David Harvey (1989) for instance referred to it as “time-space compression” whilst Giddens (1990) saw it as “time-space distancing”. Manuel Castells, in his seminal trilogy, *The Network Society* (1996, 1997 and 1998), emphasizes simultaneity in social relations across space, so that the global economy functions as a single unit in real time. Based on this synthesis, Castells observes that “the globalization of economy, technology, and communication, and the parallel affirmation of identity as the source of meaning” (1998:311) are the two macro-trends that characterized the information age.

It is true that theories purporting to explicate the process of globalization do not seem to speak directly to universities. However, those whose approach incorporates elements of historical materialism do sketch the degree of the changes taking place within the global political economy (Castells, 1996, 1997, 1998; Harvey, 1989; McMichael, 2000; Sklair, 2002; Robinson, 2001). As Slaughter and Leslie (1997) have noted, these

changes are putting pressure on national higher education policy makers to change the way in which the business of tertiary education is conducted to fall in line with capitalist post-Fordist lean production methods. The argument is that as the competitive advantage of nations (Porter, 1990) shifts from the reliance on the availability and abundance of land, labour and capital to knowledge and information processing, the centre-periphery basis of capitalism has to be re-evaluated and revitalized in new ways (Dzisah, 2006; Hoogvelt, 2001).

In spite of this, most critics of public education's apparent failure tend to substitute a general dissatisfaction with formal educational establishments for a more sustained analysis of what schools do and why they operate the way they do (Wotherspoon, 1995). It is clear that this stems from misunderstanding of the history and practice of education. As a result, there is an "extreme faith in the ability of formal education systems either to overcome social and economic disparities or to match labour-force requirements" (Wotherspoon, 1995:485). The perception is that education systems alone should provide an efficient panacea for social and labour-market problems. This aside, the emergence of the so-called 'Asian Tigers' provided the impetus for a heightened global competition making it crucial for corporations and state agencies to work together to stimulate techno-science (Slaughter, 1998).

In addition, the economic growth of the so-called 'Asian Tigers' has necessitated the movement from bipolar trade to regional world trade. Consequently, the gain in manufacturing by these newly industrializing countries and the loss by the advanced capitalist states resulted in calls for all sorts of educational reforms. Though these developments provided a cause for concern, the question that still remains is whether

educational reforms alone could have provided the magic fix for declining competitiveness. As the Asian economic crisis has shown, educational reforms are not ends in themselves but mark transformations within which various knowledge producers have to adjust to global trends. For better or for worse, the so-called 'Asian Tigers' have provided the momentum for heightened global niche formation. As such, in the 1980s and 1990s most states in the developed world, regardless of the political party in power

pursued supply-side economic policies, shifting public resources from social welfare programs to economic development efforts, primarily through tax cuts for the business sector, but also through programs that stimulated technology innovation, whether through military or civilian R&D (Slaughter, 1998:55).

In fact, leaders of corporations, governments, and tertiary educational institutions increasingly see universities as possible intellectual property sources, more valuable in global markets as products than as free contributors to a global community of scholars. It is in this domain that globalization is adequately linked to higher education as universities are seen as the essential producers of techno-science, the basic artifact of the global economy (Slaughter, 1998).

The neo-liberal model of globalization of the economy sees the market or for that matter, the private sector as the engine of growth. All other sectors need to be brought under the dictates of the market. To achieve the neo-liberal agenda, states, provincial and federal governments resorted to cost-cutting and cost-sharing measures, which resulted in about twenty per cent budget cuts for higher education (Etzkowitz, 2002). However, though the mechanism for the transformation of the university into a market entity varies from country to country, it is often assumed as a consequence of neo-liberal capitalist ideology. This thus overlooked the possibility that the global transformations in higher education may be attributable to the occurrence of unequal trans-nationalization of capital

circuits and classes (Castells, 1996; McMichael, 2000; Robinson 2001). In fact, these transformations require new forms of institutional mediation in order to undertake accumulation.

The global nature of accumulation demands that it be less contingent on the political authority of nation-states (Robinson, 2001). In this regard, the global managers of capital (IMF and the World Bank) became the major battleground for socio-economic and educational reforms in the 1980s (McMichael, 2000). In spite of this, it is prudent to reiterate that transformations in academia have been a constant but very slow process since medieval times. Nevertheless, during the latter part of the twentieth century, especially in the 1980s and 1990s, neo-liberalism has become the common thread linking calls for universities to be self-financing. Thus, other than tuition fee hikes, the global market appears as a more attractive option, based on the manner in which it was rendered as having on its menu a cornucopia of therapies for all ailments even in the absence of serious diagnosis. But as identified by the *triple helix* model, contrary to neo-liberal expectations, the direction of recent academic knowledge production and capitalization is not toward laissez-faire. There is an important but not overriding role for government and an enhanced role for the university in the emerging science-based knowledge economy (Etzkowitz and Leydesdorff, 2001).

However, the trends towards the seemingly adoption of corporate management styles by universities should not and cannot entirely be explained by invoking neo-liberal ideology. This is because when approached in this way, we will be overlooking past historical developments. As various critical analyses have shown, capitalist economies are built on inherent inequalities. Wotherspoon, for instance, notes that the “production of

unequal social opportunities has been a systematic” but “regular feature of Canada’s education system” (1995:496). These inequalities are found not only inside society but also in academic demarcations of publicly funded universities in terms of allocation of institutional resources, as well as, the resource-endowment of individual faculties. Based on these factors, one can adequately assert that the transformations in scientific knowledge production and capitalization mirror those of the larger society.

The role of universities in the science-based knowledge economy is vital and appears to be irreversible. Granted this inevitability, recent transformations will continue to be debated. This is because at this point in time it is very difficult to say precisely what kind of political economy of knowledge is emerging. As Dickinson (2004:59) has indicated, though “impediments to change are easy to find”, the directions of change are always difficult to conjecture. It is with these diverse and contrasting debates about the process of globalization and its effects on higher education that we now move to explore science—society interactions in terms of the relationship between scientific research and economic activity.

2.7.1 Science-Society Relations: Scientific Research and Economic Activity

Until recently, universities were largely autonomous zones of free inquiry, protected from the incursions of religious and political censors. This distinctive separation makes Western universities unique cultural creations (Huff, 2006). Western universities emerged as legally autonomous entities and therefore, enjoyed a bundle of rights and responsibilities. This legal protection, and their commitment to objective inquiry protected from outside incursions were culturally unique historical developments.

As such, contemporary changes whereby capitalistic interests shift the motives and rewards for inquiry within universities represent an unparalleled historical shift (Huff, 2006:30). In spite of this, the fact that scientific research and economic activity are coupled on several levels is well documented in the academic knowledge production and capitalization literature. In terms of university—industry—government relations, the linkage is exemplified by the various attempts at the development of science and technology parks, centres of excellence, and other university-based research innovators (Castells and Hall, 1994). As a matter of fact, “any one reviewing the history of academic research can find intimations of university-industrial collaboration in the nineteenth and early twentieth centuries” (Huff, 2006:30).

Based on this science—society interactions, sociologists from diverse perspectives have devoted quite a significant amount of time and effort to surveying the centrality of knowledge and the relationship between knowledge and industrial structure. The way and manner this relationship is explored differed but has largely been captured by Daniel Bell (1973) as ‘axial principle and axial structure’. Marx viewed the production of commodities as the axial principle of capitalism with the business firm as its axial structure. For Weber, the process of rationalization is the axial principle for understanding the transformation of the Western world from tradition to modernity. For Raymond Aron, machine technology is the axial principle of industrial society and the factory as its axial structure (Bell, 1973). Drawing upon these sociological scholars, Daniel Bell argued that the idea of “axial principles and structures is an effort to specify not causation but centrality” (1973:10). As such, by arguing that knowledge had become the ‘axial principle’ of the post-industrial society, Bell’s aim was to uncover the primary

changes in the social structure and how advanced capitalist societies were dealing with them.

Similarly, Stehr (1994) draws not on Bell's conceptual use of an 'axial principle' but the framework of post-industrial society to detail the shift to ever-greater dependence of the economy on knowledge production. He conceptualizes knowledge as the capacity for social action. For Stehr (1994), the range and the forms of knowledge that science makes available has expanded dramatically. Science is also increasingly the only source of knowledge. As such, for him, each change in the available knowledge radically expands the options for social action. Furthermore, since the investment in, the distribution of, and the reproduction of scientific knowledge change as well, social action is bound to acquire greater social significance, as does of course, the production of knowledge. For Stehr (1994), the zero-sum quality of knowledge makes knowledge a public good. Thus, knowledge even if sold, "enters other domains but still remains within the domain of the producer" (Stehr, 1994:94). As a result of its qualities, knowledge is often seen as a collective commodity *par excellence*. For instance, the ethos of science demands, at least in principle, that it be made available to all (see Merton, [1942] 1973).

Despite this, it must be stressed that knowledge is practically on no account, regardless of its character, unchallenged. In science, the contestability of knowledge is often seen as a sign of one of its prime virtues (Stehr, 1994). As Simmel ([1907] 1978:438) argued the contested character of knowledge in practical circumstances is often repressed and/or conflicts with the exigencies of social action. However, the unlimited potential and the accessibility of knowledge, which does not affect its meaning,

makes it in peculiar and unusual ways, relatively resistant to private ownership (Stehr, 1994).

In another but similar context, Owen-Smith and Powell (2001) looked at changes in the intellectual property regime as a consequence of the enactment of the Bayh—Dole Act of 1980. They argue that the differential outcomes in knowledge capitalization by universities are steeped in distinctive institutional contexts that shape the transfer of knowledge from public sources to private firms. To them, the institutional prestige of research universities is increasingly defined in terms of both academic and commercial science. Nevertheless, both the process and the success rate for transferring high profile basic science into commercial development varies significantly across US research universities. At some institutions, promising basic science moves into the commercial realm with few missteps and delays, resulting in healthy revenue streams, close and productive relationships with industry, and broad intellectual property portfolios. In contrast, other campuses with strong basic research programs have floundered in their efforts to commercialize scientific discoveries (Owen-Smith and Powell, 2001:99). In spite of this, the growing commercial engagement has not, thus far, altered the research culture of universities so as to privilege applied orientations at the expense of basic science (Owen-Smith and Powell, 2003).

Another sociologist who has analyzed the intersection of scientific research and economic activity is Gerard Delanty (2001). He employed a historical sociological approach to argue that the university is a paradigmatic expression of what Habermas

(1972) has called the ‘project of modernity.’⁶ Delanty (2001:32) described four major revolutions that to him have shaped present universities. These revolutions, which mirror the major ruptures in modernity, are:

- i. The German academic revolution of the idealist philosophers. That is, the Humboldtian University, which inaugurated the liberal, humanistic university of the nineteenth century.

In this period of high or liberal modernity, the Enlightenment project brought about the rationalization of culture in the name of universalistic science. This was followed by:

- ii. The American academic revolution. This led to the birth of the twentieth-century university—the civic university—based on disciplinary organized knowledge and the accreditation of professionals.

In this period of ‘organized modernity’, the university, though still an elite institution became linked with the industrial mode of production, societal modernization, and turned out to be a key institution of the democratic national state.

- iii. The democratic revolution of the second half of the twentieth century led to the mass university.

In this period of ‘late modernity’, the university was linked to the transformative project of democratic politics and entered the life-world, and

- iv. The coming global revolution of the twenty-first century—the post-modern era—marks the current situation, in which the university dissolves disciplinarity, institutionalizes market values and enters the information age.

On his part, Etzkowitz (2002) traced the transformation of the university from one that was engaged in the conservation, preservation and production of knowledge to one that has undergone two revolutions. Using MIT as a springboard, he notes the shift in the

⁶ Habermas’ project of modernity deals with the professionalization of knowledge and of cultural reproduction in the autonomous spheres of science, art, and morality (Habermas, J. 1972).

mission of the university and its faculty over the past four decades. Prior configurations of university—industry relations’ he noted involved payment for consultancy services rendered by the academic community for industry. Consequently, the separation of academic from industrial science has left control of

commercial opportunities of academic research in the hands of industry whereas control over the direction of research and the choice of research topics was left to academic scientists. Although regular payments were made to individual consultants, the large-scale transfer of funds from industry to the university was left up to the generosity of companies (Etzkowitz, 2002:13).

In spite of the monetary exchanges that were taking place through consultation and philanthropy, for the sake of maintaining boundaries, university—industry interactions were heavily policed (Etzkowitz, 2002). However, the fact that academic scientists have a long history of working with industry, efforts to rigidly police the boundary separating basic and applied research could not deter academic scientists who were willing to link their work to real world problems.

While these seem very interesting, some critics were nonetheless unimpressed by these transformative changes in academic knowledge production (see Axelrod, 2000; Turk, 2000; Noble, 2001; Polster, 2000). They argue that the intensification of research collaboration with industry and the pursuit of economic policies by the university are curtailing academic freedom, the ivory tower role of the university, and the value-free basis of knowledge production. As such, in the next section some of these viewpoints are critically examined.

2.8.0 Public vs. Private Gains: Ideals and Challenges of Academic Capitalism

The process of globalization has deeply affected higher education by driving most public universities into the global marketplace. According to Slaughter and Leslie (1997), academic capitalism defines the reality of the growing milieu of public research universities. This contradictory atmosphere offers academic faculty and other professional staff the opportunity to apply their human capital stocks in increasingly competitive situations. This section of the study will focus on works that portray the dangers inherent in academic knowledge capitalization. It must be noted that although the authors represented here do not express homogeneous viewpoints, attempt is made to draw upon the commonalities and differences in this body of work.

James Turk (2000) argued that the fundamental function of universities in a democratic society is at risk as a result of the growing commercialization of universities. This to him stemmed from the deviation of the university from its central mission—the transmission, preservation and conservation of knowledge. As he puts it, “alone among social institutions, the university’s mission is unqualified pursuit and public dissemination of knowledge and truth” (Turk, 2000:3). The university, for him, served the general interest of the public by engaging in informed analysis and obdurate values of academic integrity (Turk, 2000). The genesis of the changes which to him has resulted in the drift by universities from the liberal type of education has been corporate interests that he believed have pushed “universities to redefine whom they exist to serve” (Turk, 2000:10). The crust of Turk’s argument is that in spite of the fact that education has always been a contested terrain, recurrent cuts in public funds by most governments in the developed world has resulted in a closer universities—industry relations.

Based on this line of argument, he asserted that there are “warning signs that commercialization is steering academic research” (2000:10). For him, these signs are traceable to previous but more specifically recent changes in the government funding agenda. He cited one of the Canadian government’s newest and most richly endowed programs, the Canada Foundation for Innovation (CFI), as proof of this. To be eligible, the “CFI requires that researchers raise 60 cents for every 40 cents they receive from the CFI’s 1.8 billion public endowment” (Turk, 2000:10). Based on these figures, he argued that the “growing dependence on private funding for university research shapes what gets studied” (Turk, 2000:11). A result of this phenomenon is that basic research, which is the groundwork for all intellectual progress, is being neglected because it lacked short-term commercial return (Turk, 2000).

Consequently, according to some researchers, the desire to attach an instrumental goal to all university research converts the university campus to a site for capital accumulation (Carroll, 2004; Noble, 2001). As the voices of corporate capital reverberate within Canadian universities, academia becomes corporatized, turning the universities into key subsidiaries of the production process (Carroll, 2004; Noble, 2001; Newson and Buchbinder, 1990). In addition, David Noble (2001) argued that the new interest in information technology for distance learning is entirely commercially driven. In his view, it is not technology or learning but the commodification of higher education that is driving the mania for correspondence courses (Noble, 2001). In this regard, university—industry relations have undermined the autonomy of knowledge, academic freedom, and have reinforced the hierarchical structure of universities by giving control to central administration (Rhoades and Slaughter, 1991). Paul Axelrod (2002) concurred and added

that there is the likelihood that a decade from now our universities will resemble little more than giant training warehouses, where short-term corporate needs will dictate curricula to students who will be increasingly taught not by professors but by advanced, impersonal technology.

In a similar vein, Slaughter and Leslie claim that there is “a loss of the university as a community, where individual members are oriented primarily toward the greater good of the organization” (1997:22). Delanty (2001) added that in these circumstances academic capitalists will gain power as middle managers and professors will lose power. In addition, as education is commodified and the university becomes no different from any other business venture, teaching will suffer. However, one cannot deny the reality of the contradictions that come with the university’s visible presence in the global marketplace. One such contradiction has to do with the fact that academic capitalists are subsidized primarily from the same sources and for many of the same reasons, as are industrial capitalists. So in some instances, both the university and industry derive their funding from the public coffers (Slaughter and Leslie, 1997). However, this does not mean that the university will solve all of its problems by embracing market ethos.

As the university moves into the global market, new problems will arise especially in regards to the issues of ownership of knowledge and secrecy in terms of research findings as is the norm in industrial practices. As Graham (2000) has noted, secrecy pervades the whole realm of university—industry donor agreements. Secrecy to him has in our time “moved to corporate-industrial sponsored research, as governments promote university—industry partnership for commercializable research as engines for national economic growth while shielding them from public scrutiny” (Graham, 2000:

25). In Graham's account, secrecy is mandated by the crass commercialization of knowledge in collaborated research and donor agreements. He indicates that the "bias of money steers research topics as well as methods" and since university teaching is so closely tied to research, it steers teaching programs and course contents as well. Commercialization of "knowledge in the present context is emphatically not in the public interest" (Graham, 2000:26).

Paul Axelrod in his work *Scholars and Dollars: Politics, Economics and the Universities of Ontario 1945—1980* (1982) sought to probe two central problems. The first relates to the vulnerability of higher education to shifting perceptions of its economic importance, and the second demonstrates the continuous difficulty universities face in attempting to achieve economic goals. He noted that the assumptions that accompanied the expansion of universities in the 1960s were remarkably similar to those that combined with the spending restraints of the 1970s. In this period, higher education was valued not for its ideals, but primarily for its products—skilled professionals who would contribute to economic prosperity. He was very critical of works on universities and colleges, which to him usually constitute only a single chapter or a few paragraphs of studies on the role of the state in modern capitalists' societies. As he puts it, in such works the "dominant role of businessmen in the university is assumed, proven with selected evidence, or not proven at all" (Axelrod, 1982:5).

Thus, without more intensive analysis, many questions about the relationship between the corporate, government and university worlds remain unresolved (Axelrod, 1982). The study concluded with the observation that, although universities proved to be imperfect instruments of economic development, the very efforts they devoted to this

function badly compromised their fundamental role as islands of culture and critical thought in a materialistic society. He, however, indicated that the university—industry relations seem to have been more a matter of cultural leadership than an overt attempt on the part of corporations to control research and teaching (Axelrod, 1982).

In two recent works, Axelrod (2000 and 2002) laments the shift towards applied research at the expense of basic research. He indicates that university research that contributes to prescribe commercial purposes earns greater support and recognition than curiosity-based inquiry that is so central to scholarly independence and the discovery of new knowledge (Axelrod, 2002). As he puts it “academic researchers—in the arts and sciences—who skew their scholarship to serve the interest of funding sponsors threaten the integrity of the university by surrendering their intellectual autonomy to influential patrons” (Axelrod, 2002:41). However, he does not place all the blame on the doorstep of university—industry relations. He acknowledges that the problem stems from the stated goals of liberal education, which sometimes are so “all-encompassing that everything, including job training and applied research appear to fall within its domain” (Axelrod, 2002:5). The problem for him has become more challenging because universities are simultaneously declaring their undying commitment to the ideals of liberal education, but yet, are marrying more and more of their academic life to the assumed needs of the marketplace.

For Axelrod (2002), research funded primarily by private industry will be designed to produce profitably sold products, and will no longer engage the study of non-marketable ideas. This in his opinion has, in most public universities, resulted in the marginalization of the Humanities, Social Sciences, and the Fine Arts. In spite of this, he

indicated that the liberal arts and the academics employed to teach them have in a way benefited, at least indirectly, from a prevailing popular belief in the job-training function of higher education. As such, it is naïve for academics to “assume that universities would be supported or enrolled at current levels if the institutions were stripped of their economic role in favour of an exclusively cultural one” (Axelrod, 2002:31).

Wayne Renke (2000) tried to look at the private and public dimensions of the issues of commercialization. He addressed the issues from the perspective of a perceived risk in commercial take-over of Canadian universities. He indicated that whether risks have become realities required investigation of particular circumstances (Renke, 2000). While acknowledging the reality of the apprehension of risks, he indicated the need to avoid exaggeration in this discourse. As he puts it, we cannot “assume that just because a researcher is paid by a particular sponsor, the researcher will abandon his or her scholarly integrity to favour the sponsor” (Renke, 2000:33). If we choose to speak of the risk of business investment in post secondary education, it would be “churlish at least not to mention the benefits of business investments.” This is because without these supports, “some research would not be done” (Renke, 2000:33). In addition, it is true that many students hope that their education will get them good quality jobs outside the walls of most universities. However, those students who are academically inclined may hope that their jobs secure academic appointments (Renke, 2000).

However, a recurrent supposition in the literature is that there is a conflict between university values and economic values. In fact, conflicts of interest are embedded in any role and must be negotiated. This is true of academic norms and

industrial behaviour. However, in the case of academia-industry relations, critics are of the view that

certain kinds of activity must occur in a setting that is de-coupled from the economic sphere of efficiency and profit making. There are instances of conflict of interest and cases of conflicting interests. The ethical requirement is not to prohibit conflicts of interest but to regulate and adjudicate conflicting legitimate interests (Etzkowitz, 2003a:116).

In this regard, conflicts of interest may “signal transition to a new academic model” by exposing “assumptions about the purpose of higher learning and the legitimacy of an economic role for the university” (Etzkowitz, 2002:14-15). Based on similar assumptions, critics decry the so-called ‘publish or perish’ syndrome as if it was the root cause of seemingly decreased attention to teaching. Having touched on the crux of the critics’ arguments, the task now is to consider three works that seek to empirically understand the transformations in university—industry relations.

2.9.0 Empirical Dynamics of Academic Knowledge Capitalization

While there is an extant literature on university—industry research relations, these works, with few exceptions, rarely test the prevailing fears and concerns about the dangers of commercialization. More often than not works on the interaction of university—industry—government relations are theoretical in nature with little or no attempt to test underlying variables. As noted by Kleinman and Vallas, a significant chunk of early research into university—industry relations “adopted a primarily moral stance, lamenting the so-called erosion of traditional academic norms or, more narrowly, of the normative structure of science” (2001:456). Fundamental to what these early works detailed as endangered was the autonomy of scientific practice. Michael Polanyi (1962) characterized this ideal in the ‘Republic of Science’ where he defined the autonomy of

science as existing when the “choice of subjects and the actual conduct of research is entirely the responsibility of the individual scientists, [and] the recognition of claims to discoveries is under the jurisdiction of scientific opinion expressed by scientists” (1962:54). This ideal paralleled Merton’s ([1942] 1973) classical statement on the normative structure of science discussed earlier. As such, this section focuses on two works that are empirical in nature—Blumenthal et al. (1986) and Kleinman (2003).

Blumenthal and his collaborators undertook a survey of 1200 biotechnology faculty in 40 of the most research-intensive US universities. The purpose of the study was to ascertain the empirical basis of many of the fears and concerns that critics’ of university—industry research relations have about these research activities. Though the research only involved the biotechnology faculty, the result was generalized across the broad spectrum of the academia. The study found that 30 per cent of biotechnology faculty who received funding from industry acknowledged to some or to a great extent the influence of commercial considerations on their project choices. Only 7 percent of those who did not receive industrial support said commercial factors influenced project choices (Blumenthal et al. 1986:1364).

The study also explores the concern that academics that received industrial support are perhaps less interested in and are not dedicated to traditional university activities. Here, the argument is twofold. First, the fear is that entrepreneurial faculty will become interested in knowledge capitalization and thus pursuing more applied research that is of less cerebral value. Second, that their involvement with industry will persuade them to partake in time-consuming tasks that will compete with university activities vital to the health of the universities and the scientific discipline (Blumenthal et al. 1986).

However, the results indicated that compared with colleagues engaged in biotechnology research, faculty receiving industry support reported significantly more publications and involvement with other professional activities but no statistically significant difference in teaching time (Blumenthal et al. 1986:1362).

Another aspect of university—industry research relations that their study probed was the argument that university—industry research arrangements may create incentives for faculty to keep their research secret and that industry is more likely to impede publication of research findings. Indeed, some aspects of their findings lend support to these concerns. The authors found that biotechnology faculty with industry support were four times as likely as other biotechnology faculty (12 versus 3%, $P < 0.001$) to report that trade secrets had resulted from their university research⁷. Among biotechnology faculty involved in university—industry research collaborations, 24 per cent reported that they have withheld information based on industrial sponsored research and only five per cent among faculty without industry support responded of doing the same (Blumenthal et al., 1986).

In addition, biotechnology faculty disclosed that their research choice had been affected by the possibility that the research outcome would have commercial relevance. Faculty members with industry support were more than four times as likely as faculty without industry funds to report that such considerations had influenced their choices to some extent or to a great extent (Blumenthal et al. 1986:1365).

While Blumenthal and his colleagues have acknowledged the limitations of their study, the study has in a way strengthened the position of observers on both ends of the

⁷ In the study, trade secret was defined as information kept secret to protect its proprietary value (Blumenthal, D. et al. 1986).

debate on university—industry relations. However, it would be a mistake to assert that current university—industry relations constitute a novel threat to academic autonomy and faculty’s control of the research agenda. It would equally be problematic to state that university—industry partnerships mark an extraordinary incursion into the idyllic free exchange of data and research materials (Kleinman and Vallas, 2001). Research has shown that even in the absence of commercial considerations, information, data and research materials do not always flow unreservedly. Inter-lab competition often makes researchers averse to supply research materials to their colleagues. Also, failure by scientists to “maintain adequate biological materials in their laboratories makes it impossible for the scientists to supply the materials to other researchers upon request” (Kleinman and Vallas, 2001:456).

In fact, a recent survey of life scientists found that 24 per cent of respondents said that financial interests in or agreements with a company affected their decision to withhold information. But almost twice that many respondents said that they withheld data or materials from colleagues to protect their scientific lead, and another 27 per cent said costs affected their decision to restrict the flow of data or materials from their lab (Kleinman and Vallas, 2001: 459-460). Based on these considerations, Shapin (1988) suggested that it is appropriate to consider scientists as investing their particular scientific capital in different ways to defend and prosecute their interests with or against others.

It is clear that in the current transformations of academic knowledge production, various socio-economic and administrative factors are at work. These factors are at the core of the next empirical effort directed at understanding the influence of the social environment on university—industry relations. The work in question here is the eclectic

volume by Daniel Kleinman—*Impure Cultures* (2003). This work stems from an ethnographic study of the Handelsman Biology Laboratory at the University of Wisconsin—Madison.

Kleinman (2003) examined two interconnected issues. He explored ways through which we can productively think about commercial influences on academic science, and the need for a better understanding of the practice of university science through the analysis of structure rather than a narrow focus on agency. His assertion is that by overly focusing on possible threats to the university from direct and explicit relationships in university—industry relations, we glossed over the less overt, but far more pervasive effects of commercial factors on the practice of academic science. Unlike some scholars of university—industry relations (see Fujimura, 1988; Knorr-Cetina, 1999 and 1981; Latour and Woolgar, 1986; Lynch, 1985), he contended that more attention must be paid to the structure of constraints inherent in the intellectual property regime in which academic scientists in the US operate, rather than, to how patent-related restrictions of information result from relationships with for profit-entities (Kleinman, 2003:116). This is because even when the relationship does not involve the economic interests of industry, universities are still indirectly affected by the commercial world.

To underscore the pervasiveness of the indirect influence of commerce on the academia, he cited an interesting but intriguing case that was reported in the 1997 fall edition of the journal *Science* concerning the effect of a ‘materials transfer agreement’ (MTA). According to the report, two University of California scientists asked a colleague in Oxford University in England to provide them with some mammalian DNA sequence that the Oxford colleague had developed. The California scientists wanted the material

for an experiment involving *transgenic* mice. Before Oxford would send out the genetic material, they asked the University of California researchers and their non-profit sponsors to sign an agreement in which the scientists would surrender any intellectual property rights for inventions developed with the genetic material (Kleinman, 2003:125-6).

In addition, Oxford requested the right to preview and comment on articles arising from the scientists' research. According to the scientists interviewed for the article, these kinds of requirements are increasingly common in certain areas of the life sciences. He draws on this case to show that even in the "absence of direct corporate interest, universities take actions that mirror the commercial norms that increasingly shape academic decision-making" (Kleinman, 2003:125-6). He noted that it is impossible to understand the dynamics and character of contemporary academic science without understanding the social environment in which the university as an institution and university science as a product are embedded. It is imperative to understand that "commerce, in the broadest possible sense, is a significant element of this social environment, and will consequently play a part in shaping the practices of university science" (Kleinman, 2003:138-9). Thus both direct and indirect influences and perceptions must be taken into account when analyzing the issue of the setting of research agendas, control and influence. In the next chapter, I build on the issues discussed here to further develop the conceptual framework of this study.

Chapter Three

3.1.0 Functional and Institutional Transformations in the Regime of Knowledge Production

Universities have always been involved in the practicalities of the world (Jacob and Stewart, 2004). In spite of this, attempts were made to distinctively separate basic from applied science (Kleinman, 1995). The outcome of this separation was that it left the management of commercial prospects of academic science in the hands of industry whereas control over the choice and direction of research was left at the discretion of academic scientists (Etzkowitz, 2002). However, due to the mounting evidence of institutional boundary crossing, attempts were made to police the thin line separating university—industry research relations through the institution of the one—fifth rule (Etzkowitz, 2004). The one—fifth rule was meant to regulate “consultation, the utilization of contracts to formalize hitherto informal university—industry ties, and the patent system to protect intellectual property” (Etzkowitz, 2004:67). What, however, emerged were the “traditional academic committee process to review inventions and an external organization, the Research Corporation, to market the patents to industry” (Etzkowitz, 2004:67). This move was followed by the establishment of an organization within the university, the technology transfer office, tasked to pursue these policies on a more intensive basis (Etzkowitz, 2004).

The above policy shifts instead of guarding against the crossing of boundaries have rather accelerated the process of boundary crossing. As a result, some academic scientists have fully embraced entrepreneurial culture in their research undertakings. In spite of this, how do we make sense of the functional and institutional transformations in the regime of knowledge production? In the sociological literature on academic scientific knowledge production and capitalization, two models readily stand out as explanatory tools: *The New Production of Knowledge* and the *Triple Helix of University—Industry—Government Relations*.

3.1.1 The Transition from ‘Mode 1’ to ‘Mode 2’ Knowledge Production

Michael Gibbons and his collaborators in their seminal work the *New Production of Knowledge* (1994) sought to theoretically explain current changes in the sites of scientific knowledge production. They examined the landscape of knowledge production and came to the conclusion that the conventional divide between theoretical work and applied research is breaking down and being replaced by a new model in which traditional disciplinary boundaries are less important (Gibbons et al. 1994; Hohendahl, 2005). Accordingly, the way in which scientific knowledge, technical application, industry, education and society are organized and function today lies in keen contrast with past practices and relationships (Gibbons et al. 1994). Gibbons and his collaborators discussed the transition from ‘Mode 1 to Mode 2’ in order to make sense of how current transformations differ from preceding relationships. They also detailed how these new changes are impacting upon the way scientific knowledge is produced. In their account, a division between academia and society exemplifies ‘Mode 1’. In this mode, the scene of

knowledge production is institutionally differentiated from the site of application (Baber, 2001; Gibbons et al.1994; Hohendahl, 2005; Shinn, 2002).

In contrast, 'Mode 2' knowledge production "perceives the weakening or collapse of the modern university, the disappearance of scientific discipline and the atrophy of peer control over the direction and content of research programmes" (Shinn, 2002:600). In this new mode, knowledge production becomes part of a larger process in which discovery, application and use are closely integrated (Gibbons et al.1994). Stated differently, scientific, technological and industrial knowledge productions have all become closely intertwined. As a result, 'Mode 1' science has to give way to the new 'Mode 2' science else 'Mode 1' would hinder the production of pioneering and useful knowledge. Consequently, interdisciplinarity is seen as the necessary and desirable result of the new academic climate since the research process itself has become heterogeneous and organizationally transient (Gibbons et al. 1994; Hohendahl, 2005).

As such, operating in the new dynamically competitive environment means working with regimes of knowledge production similar to 'Mode 2', which are based on both competition and teamwork and on the steady reconfiguration of resources, knowledge and skills (Gibbons et al. 1994). Nevertheless, if the emergence and consolidation of modernity led to the rise of distinctive institutions like university, industry and government, then the movement towards interdisciplinary knowledge production must furthered the re-mapping of those very establishments that made formally differentiated disciplines possible (Baber, 2001).

3.1.2 The Evolution of University-Industry-Government Relations in Canada

In the Canadian context, the evolution of university—industry—government relations has been through at least three phases. The first phase (pre-World War II) involved what can be called Canadian ‘corporatism’ (Langford, Langford and Burch, 1997). This stage witnessed an informal fostering of the free exchange of expertise among different sectors through government initiatives. This stage, in its infancy, tended to confuse issues of who worked for whom. However, the blurring of sectoral boundaries improved in the second phase—1955-1980. This period corresponds with the global institutionalization of science, and thus in character equaled the contemporaneous dramatic growth of universities. This combination in a way has broken “down intersectoral communication networks” (Langford, Langford and Burch 1997:21). However, the third phase—post-1980, saw the completion of the ‘Canadianization’ of universities and industrial laboratories fostered by the emergence of better communication networks (Langford, Langford and Burch 1997).

In addition to the above, one can within the Canadian context illustrate the emergence of the *triple helix* using three examples. The first is agriculture, an area in which government support for research was particularly appropriate because of the small size of the typical industrial unit—the farm. The Federal Department of Agriculture’s role in the development of strains of wheat that could withstand the ruthless Canadian winter exemplified the emergence of trilateral relations (Langford, Langford and Burch, 1997). The second foray in the development of the *triple helix* interface has to do with the enlistment of the University of Saskatchewan by the ‘Associate Committees’ of the National Research Council (NRC) in the search for a solution to the disease of wheat rust,

which between 1916 and 1930 was costing the Province of Saskatchewan about \$25 million in losses per year. Such ‘Associates Committees’ created networks of experts from university-industry-government sectors to deal with the problem (Langford, Langford and Burch, 1997). The third illustration of a collaborative research effort was the development of a sulphate-resistant concrete, which addressed the corrosive effects of alkaline groundwater on concrete in a prairie setting.

Although direct private-sector involvement in research was virtually non-existent at this period, what did emerge in the late 1920s was the support of umbrella organizations, industry-surrogate sponsors, such as the Board of Grain Commissioners, the Canadian Wheat Pool, as well as the National Research Council (NRC), for research conducted at Canadian universities. Thus in the case of cement on the prairies “university research capability and private-sector involvement allowed government to play a largely supporting role which still reflected strong networking between government laboratories and universities” (Langford, Langford and Burch 1997:23). Consequently, the evolution of a Canadian *triple helix* should be seen from the perspective of intersectoral networking, which was aided largely by high-tech communication. As Langford, Langford and Burch have noted, “it appears that the existence of critically complex communication networks out of which innovations may crystallize was as important as, or more important than, explicitly articulated government policies” (1997:21).

It is clear that the key to understanding the development of the *triple helix* model in the Canadian context is the existence of high-tech communication and the formation of networks. However, this cannot be generalized to mean that there is a coherent *triple helix* relation. The functional and institutional differentiations are ongoing and with the

global transformations in ICTs, which are synergistically networking and linking knowledge producing centres, it may not be long before one begins to talk about the *triple helix* in Canada as a homogeneous entity. However, it is necessary to add that although policies encouraging universities to look beyond their precincts are far reaching, they are at the same time embedded within the historical development of capitalism. As such, having surveyed the development of *triple helix* relations in terms of research and development in Canada, the task of the next section is to explore the genesis of Canada's national system of innovation and the mode through which these developments transformed academic science.

3.1.3 The Development of Canada's National System of Innovation

It is clear from the preceding section that the development of a Canadian *triple helix* was the results of the utilization of communication channels put in place by federal and provincial governments. These developments set the foundation for Canada's innovation system. Jorge Niosi surveys the landscape of innovation in Canada in his path-breaking book *Canada's National System of Innovation* (2000). This work focused on the making of the post-war national system of innovation (NSI) in Canada. He indicated that during and after World War II, over 30 research universities, 150 government laboratories, and dozens of government policies aimed at nurturing innovation in private firms, academe, and government organizations were underway in Canada. In this systematic study, Niosi (2000) concluded that Canada has been relatively successful in creating a NSI as a result of several schemes and innovative techniques that the federal government, in particular, has put into action.

In Canada, as was the case in the US during World War II, the Department of National Defence took upon itself the task and responsibility for all military research and development (R&D) activities. However, in 1946, the National Research Council (NRC) created a licensing agency, the Canadian Patents and Development Limited (CPDL), to transfer to private industry the commercially useful results stemming from public research. The CPDL expanded its scope by signing an agreement with other federal laboratories, which invariably made it the central management agency of government's IP. In the immediate post-war period, the federal laboratories were extended outside the Ottawa region, helping to create a semblance of a truly NSI (Niosi, 2000).

In 1948, the Prairie Regional Laboratory was founded in Saskatchewan to conduct research on the industrial use of agricultural waste and surplus. At the same period, the university system, which at the turn of the century comprised only two graduate degree offering universities—University of Toronto and McGill University—grew rapidly (Niosi, 2000:45). However, it was not until the 1960s that the links between diverse agencies of the NSI very rapidly developed. Indeed, until the 1960s, the division of labour in terms of innovation was based on three distinctions: universities and other public laboratories were seen as carrying out basic research, government laboratories were perceived as conducting mostly applied research, and industry was undertaking development based on university and government research (Niosi, 2000:47).

In fact, as was the case within the context of development and underdevelopment, the rationale for this linear model of innovation followed the prescriptions of modernization theory. The idea was that one way or another, “knowledge would flow from one group of institutions to another and economic development and welfare would

naturally follow” (Niosi, 2000:47). In the 1960s, the credibility of this model was increasingly challenged by empirical studies on spill-overs and externalities. In addition, routine budgetary limitations pushed governments to increase checks and balances on the way cash flows into research agencies. This was meant to increase the efficiency and the intensity of knowledge flows between economic agents (Niosi, 2000). Nevertheless, the signs of a maturing national system of innovation in Canada were beginning to be seen all over the country. The result was an exponential growth in the number of university—industry—government laboratories. Canada had over one hundred government laboratories, mostly federal ones, and a similar number of other large university research centres, and over two thousand industrial cooperative laboratories (Niosi, 2000:48-49). At this time, the NSI was at work, and was beginning to “exhibit some valuable synergies and dynamism, even if it did not show major coordination, either by the market or by public hierarchies” (Niosi, 2000: 48-9).

In order to reinforce and build upon the gains made, the early 1960s saw the introduction of new federal tax deductions for industrial research. This new tax policy was aimed at inducing more industrial research, whether in-house or contracted out. The policy allowed private companies to deduct most R&D expenditures from taxable income. This policy change was followed by the initiation of new programs directed at promoting cooperation between industry and universities, with greater emphasis on the academic side (Niosi, 2000). The emergence of these new policies resulted in the creation of the Medical Research Council (MRC) in 1960. The MRC was created under the NRC to promote basic and applied research, as well as clinical testing. However in 1969, the MRC became autonomous. This was followed by the creation of the Natural Sciences and

Engineering Research Council (NSERC) and the Social Sciences and Humanities Research Council (SSHRC) to support research in the corresponding fields.

As noted elsewhere in this study, the dawn of the modern version of university—industry—government research relations was furthered in the 1980s, when the main research councils created matching policies to promote collaboration between industry and universities (Niosi, 1995 and 2000). These developments were, in part, due to the transformations in the global economy and the shift to ever greater dependence on science and technology-based knowledge. Having navigated the landscape of Canada’s innovation system, the task of the next section is to explore the theoretical framework of this study—the *triple helix* of university—industry—government relations.

3.2.0 Conceptual Framework: The ‘Triple Helix’ of Scientific Knowledge Production

The *Triple Helix* of university—industry—government model provides a heuristic frame of reference for a study that attempts to understand the perceptions of the production and capitalization of knowledge through its emphasis on the assessment of knowledge-based infrastructure and development options (Etzkowitz and Leydesdorff, 1997). Derived from the Boston’s regional organizing experience in the 1930s and 1940s, the *triple helix* model comprises three basic elements: First, a more prominent role for the university in innovation; Second, a movement toward collaborative relationships among the three major institutional spheres in which innovation policy is increasingly an outcome of interaction among university-industry-government and; Third, in addition to fulfilling their traditional functions, each institutional sphere also ‘takes the role of the

other' operating on a 'y—axis' of their new role as well as an 'x—axis' of their traditional function (Etzkowitz, 2006).

A *triple helix* system can be expected to exhibit all kinds of chaotic behaviour, such as unintended consequences, crises, niche formation, and self-organization. The observable configurations informed us about the selections that may have taken place, but the provisional inferences can be expected to raise further research questions (Etzkowitz and Leydesdorff, 2001). In sociological terms, the *triple helix* model can be considered a multi-structural or multi-functional framework in contrast to the structural-functionalist model in which a single function was expected to be carried by a single institution (Parsons, 1951). Merton (1957) added to this model that functions are historically contingent and can be performed by different institutions. However, how the institutions and functions operate in relation to each other could then become the focus of a research program (Etzkowitz and Leydesdorff, 1997 and 2001).

In reaction to developments in the philosophy of science (Kuhn, 1962), the sociology of scientific knowledge accentuates that functions and institutions can be considered as both constructed and reconstructed in light of socio-cognitive developments in scientific paradigms, fields, and specialties (Barnes and Dolby, 1970). As a consequence, the focus in the emerging interdisciplinary of science, technology, and innovation studies shifted from structural to action parameters (Latour, 1987). In the *triple helix* model, the focus is kept on action and change, with the assumption that the communicative actions generate codes of communication over time, so as to reduce uncertainty. According to Etzkowitz and Leydesdorff (2001), these codes of communication are able to feed back as selective structures on the generation processes,

both recursively and interactively. As a result, whether the codes are stabilized as “evidential contexts” (Pinch, 1985) or “validation boundaries” (Fujigaki, 1998) remains an empirical question. However, the stabilization of different selection mechanisms is historically contingent, both within the empirical sciences (Gilbert and Mulkay, 1984), and in relation to the relevant interfaces (Knorr-Cetina, 1999).

While the agencies at the nodes are active and recursively selective according to their own specific functions and institutional constraints, the network system of university—industry—government relations adds a layer of distributed, uncoordinated, and therefore uncertain interactions. The various representations interact and operate on each other in the transaction spaces between institutions and functions at the network level, but with different dynamics for the various partners involved (Etzkowitz and Leydesdorff, 2001). Additionally, differentiation among the codes can be maintained and/or can be expected to be blurred insofar as this is deemed functional by the various partners involved, and to different degrees given local contingencies. Consequently, the exchange processes becomes complex and can be provided with different meanings from various perspectives. As noted, these distributed network systems can also be considered as the “transaction spaces” that sometimes enable the participants to translate among the different meanings (Etzkowitz and Leydesdorff, 2001). Translations can again be organized and codified into informed and knowledge-based reconstructions and roles (Fujigaki and Leydesdorff, 2000). If this process is successfully achieved, the previously stabilized configurations can even be made more complex, flexible, and resilient (Etzkowitz and Leydesdorff, 2001).

Therefore, from the perspective of interacting sub-dynamics spanning transaction spaces, it is plausible that the institutional layers function mainly as a retention mechanism for economic wealth, archival knowledge, and “best practices,” respectively (Van Lente and Rip, 1998). The sub-dynamics—wealth creation, knowledge generation, and public versus private control—are continuously developed both in parallel and interactively. The results compete for institutionalization, but institutionalization is itself also one of the competing sub-dynamics. Thus, one can consider institutionalization in terms of its functionality for improving communication among the partners with reference to innovation. The resulting overlay of communications among the partners cannot be completed, since it remains disturbed by institutional interests, by market forces, and by unexpected innovations. All participants develop a partial perspective, and they are reflexively aware of doing so (Etzkowitz and Leydesdorff, 2001).

The *triple helix* model cannot be reified into a neo-corporatist arrangement because of its implied emphasis on the dynamics of change and the appreciation of differences in opinion, position, and interests (Etzkowitz and Leydesdorff, 2001). The institutional units of university—industry—government have to engage in exchange relations in order to participate in the innovation system by productively transforming themselves in accordance with changes in the codification structures (Etzkowitz and Leydesdorff, 2001). The interactions among the sub-dynamics provide the potential for the progressive and creative deconstruction of existing relations given ongoing changes in the relevant environments. The analytical declaration of an overlay system as a relevant level of interaction provides the tools for understanding innovation as the crucial operation of a knowledge-based economy. The missing links can then be specified

theoretically, that is, as hypotheses to be tested. The uncertain operation of innovation and the relatively unpredictable dynamics of knowledge-based innovation systems can themselves be considered as the drivers of these systems (Etzkowitz and Leydesdorff, 2001).

The reflexive mode of R&D is volatile, but one is dedicated to investigating whether the envisaged options can be realized. In order to be fruitful, variation has to be codified both recursively, that is, in relation to a previous stage, and interactively, that is, in terms of the competition among alternatives. It is not sufficient to provide the means of an innovation, but one has to convince agencies to take it further beyond the limitations of a single institution (Etzkowitz and Leydesdorff, 2001). Under the *triple helix* regime one can expect an endless transition of innovation, rather than a journey toward an assumed ideal model. In the case of knowledge-based developments one can no longer assume fixed end-points to development (Etzkowitz and Leydesdorff, 1997 and 2001).

The *triple helix* model thus perceives the “interaction in university—industry—government as the key to improving the conditions for innovation in a knowledge-based society” (Etzkowitz, 2003:295). It demarcates an interstice that makes it possible for each of the institutions of knowledge production to assume the role of the other (Leydesdorff and Etzkowitz, 1997 and 2001). In addition, the *triple helix* model emphasizes the decline of the linear model in which the various institutions worked in hierarchical systems with pre-defined roles. Consequently, in the production, exchange and the use of knowledge the *triple helix* model is characterized by four dynamic changes:

- i. The internal transformation in each of the helices, such as the development of lateral ties among companies through strategic alliances or an assumption of an economic development mission by universities.
- ii. The influence of one helix upon another in bringing about transformation, such as, the revision of the rules of intellectual property ownership to transfer rights from individuals or government to the universities.
- iii. The creation of a new overlay of trilateral linkages, networks, and organizations among the three helices serving to institutionalize and reproduce the interface, as well as, stimulate organizational creativity and regional cohesiveness.
- iv. Finally, the model points out the recursive effect of these inter-institutional networks representing academia, industry and government both in their originating spheres and the larger society (Etzkowitz et al. 2000:314).

In essence, the *triple helix* can aptly be described as a “spiral model of innovation that captures multiple reciprocal relationships at different points in the process of knowledge capitalization” (Etzkowitz, 2002:2). The institutional cross-fertilization that has isomorphically transformed universities into firms and vice versa has blurred the rigid boundaries between the institutions of knowledge production. In terms of the university, while the discipline-based departments are converging in new ways by maintaining traditional lines of research, the *triple helix* model recognizes that they are, at the same time, turning to industrial research and intermediary forms of research or are conducting research at the intersection of academia and industry. This, as earlier noted generates an ‘endless transition’ in that one no longer has to search for a single macro entity which embodies a dramatic three strand confluence but can equally do so in small variations and

variants at the micro level. In addition, co-evolutions are simultaneously taking place inside one of the three strands (Shinn, 2002).

While the thesis advanced by *The New Production of Knowledge* provides conceptual schemes that can be used to analyze the production of and capitalization of knowledge, the empirical base of the *triple helix* in this context, makes it more suitable for the proposed research. The *triple helix* model, compared with the *New Production of Knowledge*, provides the necessary fit between theory and empirical data. As such, this study is conceptualized around the analytical and theoretical parameters of the *triple helix*. Having outlined the conceptual framework, the task for the next section is to rationalize the *triple helix* as a conceptual frame of reference by comparing its intellectual structures with its closest competitor, the ‘Mode 1—Mode 2’ thesis.

3.2.1 Intellectual Structures of ‘Mode 1—Mode 2’ and the ‘Triple Helix’

As knowledge has become the primary source of development and international competitiveness in a globalized world (World Bank, 1998), universities have broadly been recognised as agents of socio-economic growth and development. In fact, the importance of universities as new sources of scientific and technological knowledge is widely recognized in the burgeoning university—industry relations literature. Within university and industrial circles, the creation and application of new knowledges have been identified as a key driver of economic growth (Agrawal, 2001). Consequently, it would be surprising if these dynamic reconfigurations of traditional disciplinary dichotomies and the emergence of the university as a site for both basic and applied research were not in tandem with the shake-up of institutional clusters in which they are being nurtured and shaped (Baber, 2001).

In terms of understanding the functional and institutional transformations of the university, I have detailed the two complementary explanatory models—the *New Production of Knowledge* (Gibbons et al. 1994) and the *Triple Helix* (Etzkowitz and Leydesdorff, 1997). However, before I proceed to discuss the drawbacks of the *triple helix* model, I would like to explain the rationale for using it rather than the *New Production of Knowledge* as the conceptual schema by focusing on their intellectual structures. The intellectual structures of the *New Production of Knowledge* and the *Triple Helix* differ significantly.

In the *New Production of Knowledge*, claims about the demise of universities, scientific disciplines and academic laboratories were expressed. In addition, the authors detailed a rise in interdisciplinarity as well as economically and socially relevant research. These changes in the landscape of knowledge production, within the framework of a new kind of socially useful epistemology, have resulted in perpetually fluid business-linked research taskforces (Shinn, 2002). However, compared to the *Triple Helix*, the *New Production of Knowledge* raises not only few questions about the evolution of science and technology, but more so, about the changes in their relations with enterprise and society. In fact, almost no concrete evidence was given for the assertions advanced nor was provision made for future empirical sociological work (Shinn, 2002:604). Even the few systematic empirical works that have been carried out with reference to the *New Production of Knowledge* have, by and large, suggested that the claims either run counter to available evidence or are at best not clearly validated by available fact (see Godin, 1998; Godin and Gingras, 2000; Pestre, 2000; Shinn, 1999; Weingart, 1997). As noted by

Shinn, these “programmatic and methodological difficulties may be a consequence of the fact that the approach lacks a theoretical referent” (2002:604).

In fact, the *New Production of Knowledge* is not specifically connected to any conceptual framework—classical or contemporary sociology. As a result, there are lingering questions about its intellectual ‘project’. It must, however, be noted that there are some promising research based on hypothesis drawn from the *New Production of Knowledge* (see Flinterman et al. 2001). However, for now in terms of its formulations, there is a denial of the differentiation between science and technology, industry and academia, as well as society and knowledge (Shinn, 2002).

The *Triple Helix* on the other hand, considers the result of an interaction between functional and institutional dynamics in society. It stresses historical continuities as key to improving the settings for innovation in a knowledge-based economy (Etzkowitz, 2003). As formulated, the *Triple Helix* captured the transformations in the functions of the trilateral nodes of knowledge production to a greater extent. It also reflects the interstices, which make it possible for each of the helices to symbolically assume the role of the other. The horizons of the *Triple Helix*, unlike the *New Production of Knowledge*, are four-fold:

- i. It has developed an empirical base, in the form of multiple case studies of changing relations between university, industry and government.

Here, the centrality of empirical data goes some way toward neutralizing the normative propensity associated with sociological models such as *The New Production of Knowledge*, which are thin on data and thus prone to sweeping generalizations.

- ii. The *Triple Helix* explicitly addresses concrete and pressing problems of university—industry—government policy.

It engages in the stimulation of entrepreneurs, university administrators and the public to rethink policy and conduct, in response to changing cognitive, technical, economic, and international trends.

- iii. The analytic thrust of the *Triple Helix* unlike the *New Production of Knowledge* is pursued via a neo-differentiation strategy.

In fact throughout much of the 19th and the first half of the 20th century, the related but distinct strands occupied by the university—industry—government functioned effectively. However, through internal events within each and the changing relations between them, there arose another differentiated unit—the *Triple Helix*—in which, the three strands are fused in a historically unique way (Etzkowitz, 2003a; Etzkowitz and Leydesdorff, 1997 and 2001; Shinn, 2001).

- iv. Finally, the *Triple Helix* model is accompanied by a theoretical framework that is couched along the lines of self-organization and co-evolutionary theory (Luhmann, 1996).

In sum, the core element of the *Triple Helix* model is centered within the traditional university. The institutional transformations occurring and the policies encouraging the university to participate dynamically as entrepreneurs' means we should be looking beyond the idolized ivory tower.

3.3.0 Theoretical and Methodological Drawbacks of the Triple Helix

Indeed there are some basic limitations as regards the way the *triple helix* is formulated. For instance, its 'neo-differentiation' perspective generates many questions

such as the concrete entities it comprises and how one would discern the fact as to whether the *triple helix* is a ‘new’ differentiation or just a readjustment that has modified environments without endangering the established institutions (Shinn, 2002). In addition, one is tempted to ask on what parameters the model’s validity hinge? That is, are entities like incubators, spin-offs, and other new forms of government—industry relations the deciding patterns on which the validity of the *triple helix* depends? (Shinn, 2002) Besides, there are difficulties with some of its mathematical formulations (see Leydesdorff, 1997 and 2002). Furthermore, there is difficulty in penetrating the theory’s insider terminologies such as ‘lock-in’ and ‘over-lays’. These have led some discussants to express unease with its theoretical pronouncements (Shinn, 2002).

Moreover, the *triple helix* like the *New Production of Knowledge* failed to take into account two important aspects of knowledge and artifact production. The first deficiency rests in its failure to recognize that the university—industry—government all function in a national setting. Although globalization is on the rise, this does not for now lead to the situation whereby the de-nationalization of science is eclipsing the national component of the organization and work of scientific teaching and research (Shinn, 2002:611). The second deficiency rests in the unhelpful way the *triple helix* deals with ‘differentiation’, a key concept in sociology. Though it retains “classical concepts of ‘differentiation’ and ‘integrations’, in practice, this simply entails the projection of long-standing cycles of integration, neo-differentiation and neo-integration through an infinity of co-evolutionary iterations” (Shinn, 2002:611).

Another possible drawback that has been noted in the literature is the exclusion of a fourth helix. Using a post-normal science approach, Mehta (2005) demonstrated how

the *triple helix* relations came under greater scrutiny when innovation generated both scientific and social uncertainty, and thereby, eroded trust. Using the Canadian public's discontent about the lack of consultation over the introduction of genetically modified food into the market, Mehta (2005) argued for the introduction of the fourth helix—the public. He indicated that the foremost concerns of the *triple helix* model are tenuous: regulating of new technologies and at the same time encouraging innovations may be challenged by the very nature of technology and the potential risks it may pose (Mehta, 2005:107).

However, Etzkowitz and Leydesdorff, (2003:57) takes up the issue of the public as a fourth helix arguing that the conceptualization of the public merely as the fourth helix narrows the public into another private sphere, rather than seeing civil society as the foundation of the enterprise of innovation. They argue that the knack of individuals and groups to organize freely, to deliberate, and to take initiatives without permission from the state, can be considered as a necessary condition for the development of a *triple helix* dynamics of university—industry—government relations that includes both bottom-up and top-down initiatives (Leydesdorff and Etzkowitz, 2003).

In my opinion, while, it is plausible to argue that the *triple helix* may not be adequately equipped as it now stands to handle issues of risk and uncertainty, including the public as a fourth helix is, however, fraught with some difficulties since the *triple helix* relates to institutions of knowledge production. The public is not an institution in the sense in which the concept is often used sociologically. More so, the public for that matter is not a knowledge producer like the other modes of knowledge production such as university—industry—government. I think the public is adequately represented within the

domain of the state, and should be subsumed under its realm. However, the incorporation of monitoring roles for extended peer community or civil society organizations will be a step in the right direction. These organizations can be brought in to act as checks and balances on over-zealous policy makers.

Having sets out the theoretical framework of the study, the next chapter details the methodological steps used to collect and analyze the study data. Methodology is the way in which the social scientist acts upon the world under investigation. It is a dynamic part of the research process that cannot be considered separately from other elements of the research. Methodology is intended to have both practical and theoretical relevance. As such, the approach chosen to gain meaningful, relevant information must both respect the real world (Blumer, 1969) and be consistent with the values and theoretical orientation of the researcher (Denzin, 1978).

Chapter Four

4.1.0 Research Design and Methodological Assumptions

This study utilizes the *triple helix* model of university—industry—government relations to analyze the production and capitalization of knowledge, using the academic scientists at the University of Saskatchewan as the unit of analysis. The *triple helix* is a multifaceted model in which knowledge production, wealth creation, and public and/or private control at the germane interfaces is carried out by its adaptive networks of communication (Leydesdorff, 2003a). In terms of evaluation of this interface, one option from the perspective of collaboration is to assess it as synergistic. However, it is possible that one may wish to be selective by choosing for one's specific interests. It is always probable that the dynamic perspectives of the participants and their participation are likely to complicate the evaluation process (Leydesdorff, 2003a: 201).

In designing effective evaluation criteria, the complex nature of the *triple helix*, notwithstanding, three possibilities can be considered. The first approach involved the problem of the nature of the indicators, that is to say, what do the indicators indicate? Secondly, there is the need for a reflexive model of how the indicated variables are related. Thirdly, the evaluation may focus on the intended or the unintended outcomes, such as, external costs (Leydesdorff, 2003a: 202). However, since data never speak for

itself, the choice of an indicator entailed an appraisal that can be examined reflexively. As a result, although, one can pragmatically select specific indicators based on the availability of a rich dataset, one always has to reason as to why such a specific measurement would be valuable for the assessment being undertaken (Leydesdorff, 2003a). There is also the need for the evaluation method chosen to inform us about policy options by providing us with “information about relations between input (independent) variables and output (dependent) variables” (Leydesdorff, 2003a: 202). Based on this insight, survey research method is employed to collect and analyze data.

4.1.1 Methodological Assumptions Underpinning the Study

The data collection process involved the utilization of a cross-method approach. The cross-method is rooted in the discourses of sea navigation and surveying (Thurmond, 2001). As a form of triangulation, the cross-method incorporates both quantitative and qualitative elements in order to reduce potential limitations that may arise from using only one method. As such the two surveys—academic scientist and Innovation Place representatives—are quantitative in nature while the in-depth interview with academic faculty is qualitative. The study involves a generic collection of data and, as such, there is no other method more suited than survey. As noted by Babbie, “surveys are excellent vehicles for the measurement of attitudes and orientations prevalent within a large population” (2001:259).

In conducting this research, the study relies extensively on questionnaires and in-depth interviews to explore transformations in academic knowledge production. Although there are two main methods of administering survey questionnaires—self-administered and staff interviews—in this study, the self-administered type is adopted in order to

primarily minimize cost and time. The survey was administered through the transmission of a questionnaire accompanied by a letter of explanation, ethics approval and a return envelope. The self-administered survey, when planned and pre-tested with care has several advantages some of which are ease, economy, and response (Babbie, 2001).

In order to collect the required data, the study used both *stratified* and *purposive* sampling method. Stratified sampling is a process of grouping members of a population into relatively homogenous strata before sampling (Babbie, 2001). As a data-collecting instrument, stratified sampling is highly regarded for obtaining a greater degree of representativeness. A sample's representativeness depends directly on the extent to which a sampling frame contains all the members of the total population that the sample is intended to represent. In the context of this study, a list of graduate faculty from the University of Saskatchewan's College of Graduate Studies and Research served as the sampling frame.

A sample size of 100 academic faculty members was drawn from the sampling frame, representing agriculture, bio—medical, computer, engineering and physical sciences. The sample included academic departments with different characteristics that were hypothesized to influence variants of the *triple helix* model such as research intensity. Thus out of the sample size of 100 academic scientists, 61 completed and returned the questionnaires giving us a response rate of 61 per cent. Based on this response rate, a further 20 per cent was selected for a structured in-depth interview to supplement the survey. These interviews captured the qualitative aspects of the study.

A sample size of 30 company representatives was also drawn from the ‘Innovation Place’⁸ research cluster. The companies were selected using a purposive sampling method. Purposive sampling is a non-probability sampling in which the researcher selects the units to be observed on the basis of his knowledge about which ones will be the most representative or useful (Babbie, 2001). Thus specific companies were selected in terms of their strengths and the sectors in which they are operating. The criteria for selecting the sectors are based on the research strength of the University of Saskatchewan. A separate questionnaire was administered in a similar manner to the one meant for academic faculty. Out of the 30 questionnaires sent out about 16 were returned giving us about 53 per cent return rates. Since the focus of this research is on academic faculty at the University of Saskatchewan, the in-depth interview was limited to that segment.

Consequently, the analysis presented in the next two chapters is based on the survey of university faculty and representatives of companies located at the Innovation Place research cluster. It must be stressed that the objective of this study was not to figure out who are the ‘winners’ or the ‘losers’ in the production and capitalization of academic scientific knowledge. The idea behind this research is twofold:

- a. to explore the perceptions of academic scientists, and other university-based researchers who are playing significant roles in the production and capitalization of knowledge, and
- b. to examine the impact of university-industry research relations on the core functions of the university.

⁸ Innovation Place is a university-related research parks developed by Government of Saskatchewan. The research park is adjacent to the University of Saskatchewan and builds on the strengths of the University.

As such, the analysis in chapters five and six focus on the implications of the transformation of academic knowledge production. The data-collecting instruments were questionnaires and an in-depth semi-structured interview. The questionnaire was designed to explore both qualitative and quantitative aspects of academic knowledge production and capitalization.

4.1.2. Quantitative Data Collection Procedures: Academic Faculty and Innovation Place

Since the study aims to understand knowledge production and capitalization, the academic faculty element of the study was drawn from the agriculture, bio—medical, computer, engineering and physical sciences. The study questionnaires were designed and pre-tested among selected sociology faculty. After pre-testing, some issues arising were addressed and the research proposal sent to the University of Saskatchewan Ethics Board for approval. The research was approved on ethical grounds on March 9, 2005. The questionnaires were then sent to the printing services for printing and packaging. The final questionnaires were sent out after a careful selection of respondents.

The selection of participants was done in stages. A sample of 100 academic scientists was selected from the University of Saskatchewan's College of Graduate Studies and Research faculty list in a two-way process. First, through a random sampling, 16 departments were selected under the general groupings representing agriculture, bio—medical, computer, engineering and the physical sciences. Secondly, having identified the various departments, all the academic faculty members in these departments were pulled together into one big sampling frame from which the 100 respondents were randomly selected. These departments were chosen because they were judged to likely contain

academic scientists whose research activities interact directly or indirectly with industrial partners or are typically engaged in both basic and applied research. The 100 academic scientists selected to participate in the study were sent a four-page questionnaire through the university's internal mailing system. If the questionnaire was not returned within four weeks an email reminder was sent and the person in question was asked if a second mailing was needed. As noted earlier, out of the 100 eligible respondents, 61 per cent completed and return the questionnaires. This is a very high return rate for a survey. As such, a follow up survey was deemed unnecessary.

In terms of the representatives from Innovation Place the researcher used Internet profiles of companies located at the research park to collect information and then used this information as the basis for a purposive sampling of participants. Here, specific companies were selected in terms of their strengths and the sectors in which they operate. The criteria for selecting the sectors are based on the research strength of the University of Saskatchewan. Sixteen companies were initially selected but some declined the invitation to participate and others did not have staff based at Innovation Place but only a contact person. As such, only representatives of nine companies completed and returned the questionnaires. Therefore, out of the 30 questionnaires sent out, 16 were completed and returned representing about 53 per cent. This was also deemed adequate and hence there was no follow-up survey.

4.1.3 Quantitative Data Processing

The self-administered questionnaires for both academic faculty and representatives of companies located in the Innovation Place research cluster were coded for identification purposes. Based on these codes, a coding manual was constructed to aid

the statistical analysis and also to make the analysis consistent. For the close-ended questions on the questionnaire, the coding utilizes numerical assignments to the responses. For instance, in the codebook, a “yes” response was coded as ‘1’ while a “no” response was coded as ‘2’. Once the codebook was constructed, the data was entered using the Statistical Program for the Social Sciences software (SPSS version 13.0). The cleaning of the data to correct data entry errors followed this step.

In addition, some re-coding of likert-scale variables from a five-category response into a three-category response was also undertaken. The data analysis was completed using frequency tables and the construction of SPSS bivariate cross-tabulation tables for both the academic faculty survey and the Innovation Place survey. The percentages in each of the cells were calculated by dividing the frequency of responses by column. Nominal variables were used as the level of measurement. Nominal measures, such as the Chi-square test of hypothesis, can be utilized to examine nominal variables as a means of determining the statistical significance of the distribution of data within the tables. It must, however, be stressed that Chi-square test, which usually requires only nominally measured variables is often computed from bivariate tables in which the number of columns and rows are easily expandable (Bohrnstedt and Knoke, 1994; Healy, 2002). The cross-tabulations included the frequencies and percentages that were rounded to the nearest integer.

Furthermore, the Chi-square value, the degree of freedom, and the statistical significance of Chi-square value as indicated through the *p* value (that is the exact probability level) were provided below each table. The statistical level represents the likelihood of the observed result. In other words, it denotes the probability of making an

error in generalizing findings from the sample to a population, what is statistically referred to as a Type 1 error (Bohrnstedt and Knoke, 1994; Healy, 2002).

4.1.4 Qualitative Data Collection Process: Academic Faculty

In terms of the in-depth interview, a letter of invitation, which also serves as a letter of consent was sent to the 25 academic faculty drawn from the pool of 60 faculty members who responded to the study questionnaire. However, before the interviews were conducted, the participants were made to sign two consent forms, one copy was for my own records and the other was for the participant's record. Out of the 25 potential participants invited to partake in this study, about 20 per cent (12 people) responded stating their willingness to be part of this study and were interviewed in their offices. This was very important as anonymity, trust and confidentiality were key factors at the heart of the ethics review process and the willingness of academic scientists to talk about their research activities.

For the sake of maintaining anonymity and confidentiality, the interviewees were given pre-allocated pseudonyms such as, 'professor 1' and so on. The interviewee and the researcher only know this number. The interviews were recorded using a cassette recorder and then transcribed verbatim. The interview transcript was, however, sent back to the interviewees to review and give their final approval by signing-off the transcript release form authorizing the use of the data under the confidentiality and anonymity conditions stipulated in the ethics approval. The twelve respondents cut across all the four broad college categories—Agricultural, Bio—medical, Engineering, Physical and Computing Sciences—that the study has focused on. The interviews, which lasted

between 30-45 minutes, were conducted during the months of September and October 2005 and are geared towards capturing the qualitative aspects of this study.

4.1.5 Qualitative Data Processing

The interviews conducted among the academic faculty in the University of Saskatchewan were recorded to ensure accuracy of information and any future verification of data. The interviews were transcribed verbatim using a desktop voice processor. Since the recorded interviews have pre-allocated numbers rather than names of individual participants, the transcribing was done under such rubrics. The interviews were coded using the qualitative software '*En Vivo*' version 2.0 to derive recurrent themes and comparisons made among participants. This is necessary to discover the extent to which respondents' research activities interact with university—industry relations, and to what extent they perceived these relations as impacting upon the university. The findings from the qualitative aspect of the study are discussed in chapter six.

4.2.0 Limitations of the Research Methodologies and the Study

In spite of the numerous benefits offered by blending quantitative and qualitative research methodologies deductively and inductively to understand a problem under investigation, these approaches are not without limitations. First, the faculty and academic departments surveyed cannot be said to fully represent the University of Saskatchewan scientific faculty. The sample for this study is drawn from academic departments that may be more applied research oriented than most academic units in the University of Saskatchewan. Also, the representatives of the selected companies located at the Innovation Place research cluster may not adequately represent the research

description of scientific practitioners. In spite of this, the population sampled still constitutes an important and interesting group whose research activities and behaviours are worthy of study.

Secondly, in spite of the high response rate for mailed questionnaires, the fact that approximately 39% of academic faculty and 47% of the Innovation Place representatives did not respond to the survey could introduce a non-response bias into the data. Though limited information does not necessarily suggest any difficulties, there is no way that the study will determine the full extent or directions of any biases that may have been created or arise from the failure of some faculty and representatives of companies located at the Innovation Place research cluster to respond to the study questionnaires.

Another possible limitation stems from the view that some faculty and particularly industrial representatives may under report or exaggerate certain behaviours or activities that they considered to be very sensitive, such as, the sources from which they receive private funding or the formula for sharing benefits that are derived from collaborative research. On the other hand, there is the likelihood that certain activities that the respondents considered desirable such as who selects the topic that a student works on in a collaborative research with industry may either be understated or overstated. Again, it needs to be stated that the extents of these biases are very difficult to ascertain.

Furthermore, while efficiency in terms of cost and time is one of the hallmarks of a self-administered questionnaire, the same cannot be said of an in-depth interview. One problem that arises in the course of this study has to do with conflict with time schedules since academic faculty are engaged simultaneously in teaching, research, administration and external affairs. It would have been more useful if the interview had lasted longer and

more questions posed but this was not possible under the prevailing academic circumstances. Besides, it would have been very ideal to extend the research sample to cover larger segments of the population such as those in the Humanities and the Social Sciences but cost and time obviously limit the realization of these goals. As such the inability to extend the research to cover academic researchers in the Humanities and the Social Sciences is to some extent a limitation of this research.

Moreover, survey research as a whole goes through what is usually termed survey error, over and above item bias. Survey error includes such issues as faults in sampling, coding, data processing, researcher and interviewer bias and data misinterpretation. Since surveys are inflexible in that an initial study design remains unchanged throughout the entire project this poses another challenge to this study. While these errors were not detected during this study, it is plausible that the study may have glossed over such incidents.

Finally, since the analysis is based on a combination of qualitative and quantitative data, meandering through individual limitations to present an overall picture is a problem that might introduce error. As such, it is possible to acknowledge that in some instances alternative questions could have been raised. In fact, differences in perceptions are a reason for future research. Despite these possible limitations, one hopes this study has made a modest contribution to the advancement of knowledge and our understanding of academic behaviour in terms of knowledge production and capitalization.

Chapter Five

5.1.0 Scientific Research and Economic Activity: The Perceptions of the Production and Capitalization of Knowledge

The purpose of this chapter is to empirically enhance our understanding of academic knowledge production and capitalization. The objective is to highlight the interaction of scientific research and economic activity from the standpoint of academic scientists. Using the *triple helix* model as a benchmark, it is argued that the growing notion that academic capitalism is harming the core functions of the university is too simplistic and that the issue is more complex than acknowledged in the social studies of science literature. It is clear from the data presented in the next two chapters that the expectation that the university should return to the idealized ivory tower is unrealistic. Instead, strategic policies are required to simultaneously capture the economic outcomes of academic scientific knowledge and preserve those sections of the university that are likely to attract fewer resources from government and corporate agencies through new and innovative funding schemes and redistribution of university generated funds.

The chapter provides empirical evidence to support the theoretical discussions presented in chapters two and three. From the analysis, it is clear that several factors are dynamically affecting the traditional functions of the university. However, the study revealed that whether professors received commercial funding or not has a significant

effect on their perception of the capitalization of knowledge. As such, it is plausible to argue that the growth of university—industry—government relations is not always predetermined in favour of either private corporations or the state, nor is it necessarily at the expense of universities. It is, therefore, possible that the future viability of policies encouraging universities to capitalize their knowledge may, if approached strategically, be a catalyst for the science-based knowledge economy. However, for this direction to be clear there is the need to understand the university as a ‘differentiated social system’ rather than a ‘unified whole’ where all research and administrative policies are considered to be identical. By understanding the university as a ‘differentiated social system’, the various colleges and departments could be encouraged to focus on their diversity in terms of institutional resources, requirements and capabilities.

The concept of the university as a ‘differentiated social system’ is based on Luhmann’s (1982 and 1996) characterization of internal differentiation that acknowledges that forms of differentiation determine the degree of complexity that a society can attain. In the context of university—industry—government relations, this differentiation should enable the university to pursue all its functions without any particular one being overshadowed. In other words, there will be a deep-seated and continually growing purposeful specialization such as the adoption of an economic development agenda in addition to teaching, research and community engagement. This understanding should supersede the way we currently view the university as a ‘unified social system’ which in principle denotes the subordination of all activities under a homogenous policy of one size fits all.

To explore the above distinctive but interconnected issues, this chapter discusses the data collected from the survey questionnaires. Under this analysis, a mixture of frequency tables and cross tabulations are used to examine the forces at work in the transformation of academic scientific research from the perspective of academic scientists and representatives of companies located at the university-based research cluster. This is done to draw attention to the process of academic capitalism, which is greatly transforming the university into the motor of the science-based knowledge economy. With this background, the rest of the chapter discusses the main findings of this study.

5.2.0 Transformations in Academia: The University and the Science-based Knowledge Economy

Though universities have always been involved in the socio-economic and political activities of the world (Jacob and Stewart, 2004), past studies of university-industry-government relations have overly focused on the impact that private corporate interests were having on the public charge of universities without any proper sociological research (Baber, 2001). However, with the rise of knowledge as the prime mover of the global economy, the economic development mandate of universities has taken on new components. As a result, academic science vis-à-vis university—industry—government relations have increasingly become the fulcrum of economic growth and development. This transformation is due to the fact that implicit in the mission statements of most public universities are economic development and sustaining roles. These latent functions are, in essence meant to aid, sustain and accelerate the production of human, cultural and social capital with the expectation that they will in the long run be combined to produce economic capital. In spite of this, the nature, substance and structure of these economic

development tasks are often vaguely left to the discretion of various stakeholders— university faculty and administration, the private sector industries, national, regional, and local governments (Etzkowitz, 2002).

As a result of the institutional transformations based on *triple helix* reconfigurations, and the acceleration of policies encouraging universities to contribute to society as dynamic entrepreneurs, there are indications that we should be looking beyond the ivory tower. Thus, instead of arguing as to whether current transformations can be reversed, we should rather be focusing on policies that can transform the university into a catalyst for the science-based knowledge economy. However, before plunging into detailed data analysis, it should be noted that the first part of the discussion is based on the academic faculty data. A different section is devoted to the analysis of data from the Innovation Place research cluster (see sections 5.4.0 and 5.5.0).

5.2.1 Gender, Science and Academic Status

The data analysis that follows does not only explore the impact of *triple helix* relations on the production and capitalization of knowledge, but also delves into issues of gender, science and academic status through the analysis of socio-academic demographics of the survey respondents. Table 1 showed the differences among academic faculty respondents in terms of gender. Out of the respondents who indicated their gender, 12% (7) were females and 88% (51) were males.

Table 1: Academic Faculty Respondents' Sex/Gender

Sex/Gender	Frequency	Percentage (%)
Female	7	12.1
Male	51	87.9
Total	58	100.0

Whilst the data presented in terms of ‘gender, science and academic status’ showed over proportionate representation of males compared to females, it mirrors the gender disparity among university faculty, especially in the fields of science (Etzkowitz, Kemelgor and Uzzi, 2000; Frank-Fox, 2001). As have been noted in various studies on gender and science, women face “special series of gender related barriers to entry and success in scientific careers that persist, despite recent advances” (Etzkowitz, Kemelgor and Uzzi, 2000:2). Consequently, at each transitional point in the tenure status the number of women decreases at a significantly higher rate than men. The decline usually continues in the movement from the classroom to the workplace. The effects of such a small number of women in science have significant unintended consequences for the socialization of female scientists as germane role models (Etzkowitz, Kemelgor and Uzzi, 2000; Frank-Fox, 2001).

Accordingly, the perpetuation of gender-linked work roles and the continuing low rate of participation of women in many scientific disciplines appear to contradict one of the accepted standards of science—the Mertonian norm of ‘universalism’ (Etzkowitz, Kemelgor and Uzzi, 2000; Frank-Fox, 2001). This norm asserts that scientific careers are open to all who have talent. However, it is clear from studies on gender and science that the scientific field and role are divided along generational and gender fault lines whereby the relatively few women in academic science willingly accepted the “strictures of a workplace organized on the assumption of a social and emotional support structure provided to the male scientist by an unpaid full-time housewife” (Etzkowitz, Kemelgor and Uzzi, 2000:105).

Whilst this study does not generally focus on women in science, it is imperative that efforts directed at bridging the gender gap in science be pursued. In table 2, academic status is explored through rank and gender. The Chi-Square value of 3.888 is not significant at the .05 level. However, it indicated that about 53% of academic scientists

Table 2: Rank of Academic Scientists by Gender

RANK	Gender	
	Female	Male
Professor	14.3% 1	52.9% 27
Associate Professor	42.9% 3	27.5% 14
Assistant Professor	42.9% 3	19.6% 10
Total	100.0% 7	100.0% 51

Chi-Square: 3.888

D.F.:2

Sig.:.143

N=58

who are males are professors, about 28% are associate professors and about 20% are assistant professors. Among the female respondents, a professor made up about 14%, about 43% of the respondents are associate professors and another 43% are assistant professors. Though table 2 is not statistically significant, it clearly showed that all professorial categories are adequately represented in this survey. This to a degree mirrored the gender dimension of rank at the University of Saskatchewan.

5.2.2 Effects of Commercial Funding on Institutional Boundaries

That knowledge has become the prime mover of the global economy has been readily acknowledged in the literature on global capitalism (Bell, 1973; Stehr, 1994; Hoogvelt, 2001; Webster, 1994). As such, the search for public policy regimes that will

address the need to translate academic scientific knowledge beyond the walls of the university have received added impetus in the developed world. This strategic policy drive aimed at re-energizing innovation systems has resulted in numerous university-community initiatives as well as knowledge capitalization schemes. However, prior attempts at knowledge production followed a linear model, whereby the site of knowledge production was entirely separated from that of application (Gibbons et al. 1994). In this linear model, there was a distinction between the sites of knowledge production and capitalization with more and more academics viewing science as a vocation. Though this method has receded in the past few decades, it has left behind, a kind of unspoken rule whereby academic scientists are precluded from taking economic advantages of the knowledge they generated within the confines of academia. However, over the years, the rigid demarcations of academia and industry have been bridged and studies have hinted at the dramatic upsurge in institutional boundary crossing (Etzkowitz and Leydesdorff, 1997; Gibbons et al. 1994). The present study explores these issues and the results are summarized in tables 3 and 4 respectively.

The issue of private commercial company funding of university research is at the heart of the debates on the consequences of university—industry—government relations. The relevance of this debate stems from the underlying linkage to privatization and the issues of autonomy, which are discussed in later sections of this chapter. In order to ascertain the veracity of claims about the privatization of the university, this study explores the extent of academic faculty’s reliance on private sources of funding.

Table 3: Private Commercial Funding of Academic Faculty

Private Funding of Research	Frequency	Percentage (%)
Yes	27	45.0
No	33	55.0
Total	60	100.0

As the results in table 3 indicated, about 45% (27) of faculty respondents indicated receiving funds and support from private commercial companies. However, the majority, 55% (33) specified that they have not received private commercial funding. The 45% of the faculty who crossed institutional boundaries and received funds from commercial companies are indicative of the assertion that the present generation of academic scientists no “longer believe in the necessity of an isolated ‘ivory tower’ to the working out of the logic of scientific discovery” (Etzkowitz, 1998: 826). However, the fact that about 55% of the academic faculty still depend heavily on the public purse to conduct their research points to the reality that there is continuity in change at the university. Consequently, as new frontiers, such as, research and economic development functions are gaining prominence, the university still retains its traditional functions (Etzkowitz, 2002).

In order to further understand the issue of funding, the study explores the relationship between *rank* and corporate funding of academic research.

Table 4: Private Commercial Funding of Academic Research by Rank

Ever Received Commercial Funding?	RANK		
	Professor	Associate Professor	Assistant Professor
Yes	58.6% 17	50.0% 9	7.7% 1
No	41.4% 12	50.0% 9	92.3% 12
Total	100.0% 29	100.0% 18	100.0% 13

Chi-square: 9.666

D.F.: 2

Sig.: .008

(N= 60)

The results showed a significant incidence of university—industry relations. The Chi-square value of 9.666 is statistically significant at the .01 level. As table 4 indicated, the rank of an academic scientist has a considerable effect on commercial funding. For instance, about 59% (17) of professors, and about 50% (9) of associate professors indicated receiving funding from private commercial sources. Only one (8%) private commercial company funding recipient was an assistant professor. However, about 50% (9) of associate professors, 41% (12) of professors and about 92% (12) of assistant professors have all not received any funding from commercial companies. The high incidence of assistant professors not engaged in collaborative research is probably due to the requirements for the award of tenure, which is based on teaching, publication record, administrative duties and community service. It may also be that since scholarly publications in the first few years are crucial for the review of tenure, some assistant professors may not be prepared to sit on their data to allow industrial partners to apply and receive patents and licenses before they move ahead and publish. This is perhaps the reason why they are not willing in their early professorial years to engage in many university—industry research collaborations.

In spite of this, the increase in industrial funding has led some critics of academic capitalism to question the rationale for university—industry relations from the perspective that it will undermine the integrity and the direction of the university. According to Turk, the genesis of this drift is corporate interests, which for him are “pushing universities to redefine whom they exist to serve” (2000:10). He argued that the outcome of closer universities—industry relations are the steering of academic research through commercialization. He traced this to recent changes in government funding

agenda, which he argued are “opening the door to private direction by requiring “partners” as a condition of researchers getting public funding” (Turk, 2000:10). But does this imply the setting of an academic research agenda? The evidence from the data provided in table 4 suggested otherwise. Therefore, to conclude that private commercial funding is setting the academic research agenda is very much debatable.

On the other hand, the fact that private funding constituted a significant part of university revenue is an indication that dollars from traditional sources have not been forthcoming as before. Stated differently, once there is a constant budget cut and the draining of student tuition options, a viable alternative for universities in a knowledge-based environment is the route that leads to the market. Thus at face value, the imbalance across campus becomes clear when explained in terms of the historical developments of capitalism. In fact, David Noble (2001) has argued that one of the most significant recent changes in universities has been the identification of the campus as a site of capital accumulation. The university campus has become a place for creating or enhancing the profit-making capacity of individuals, businesses or the country itself. As various critical analyses have shown, capitalist economies are built on inherent inequality. In the Canadian context, the production of unequal social opportunities has been a systematic, but regular feature of the education system. This has invariably served to perpetuate the inequalities embedded within the larger Canadian society (Wotherspoon, 1995).

The above changes and transformations aside, one must not lose sight of the socio-economic and political forces at work. It is only by exploring all the possible dimensions of the problem that the solution and policy guidelines will be meaningful. However, one needs to be constantly reminded of the fact that while impediments to

change are always easy to find, the directions of change are perhaps more difficult to conjecture (Dickinson, 2004). As such, my argument is that the steady increase in corporate funding and the overall growth of university-industry-government relations as it relates to research funding is not necessarily pre-determined in favour of either private corporations or the state, nor is it necessarily at the expense of the university. In fact, while research in certain areas may look promising from an economic angle, the truth of the matter is that market success cannot be guaranteed. This, in my estimation, supports Habermas' optimism that the "idea of the university cannot be completely dead" since "new life can be breathed into the idea of the university" (Habermas, 1992:107-8). Habermas (1992), however, indicated that this is possible only from outside the walls of the university. Thus private funding should be seen in 'Habermasian' terms as the breathing of new life into the academia and a consequence of globalization.

5.2.3 Capitalizing Knowledge: The Role of Spin-Offs and Intellectual Property⁹

This section of the analysis explored the extent to which academic research is being capitalized at the University of Saskatchewan. While there are other ways to capitalize knowledge, what is emphasised in this study is spin-off generated research and intellectual property (IP). It must be stated that though licensing and contracting for consulting work are major determinants of commercialization, they are not built into the survey for this study, and therefore, are not explored. However, the argument has been made that the basis for the growing blurring of the boundary between university and

⁹ Intellectual Property is used here in a very limited sense to refer to patents, International Organization for Standardization (ISO)—developed accepted standard—and Crop Cultivars.

industrial research has been the increase in consultancy work for industry by academic scientists (see Etzkowitz, 2002).

Table 5a: Spin-Off generated Research by Rank of Academic Faculty

Spin-Off Based Research?	RANK		
	Professor	Associate professor	Assistant Professor
Yes	24.1% 7	0.0% 0	7.7% 1
No	75.9% 22	100.0% 18	92.3% 12
Total	100.0% 29	100.0% 18	100.0% 13

Chi-square: 6.057

D.F: 2

Sig.: .048

(N= 60).

Based on its face and the Chi-square value of 6.057, table 5a showed a considerable knowledge capitalization at the .05 level. It demonstrated an association between rank and spin-off based research. The results indicated that about 76% (22) of professors, 100% (18) of associate professors and 92% (12) of assistant professors do not have any direct spin-off companies generated from their research. In effect, there are few professors who are doing research that have immediate industrial applicability. This is statistically significant even though the sample size is small. However, when one controls for the relationship between rank and spin-off generated research, by introducing 'ever received commercial funding', the relationship becomes statistically non-significant at the .05 level.

Table 5b (I): Effect of Rank on Spin-offs by Commercial Funding

(I) Subtitle: Ever Received Funding? Yes

Spin-Off Based Research?	RANK		
	Professor	Associate Professor	Assistant Professor
Spin-Off (Yes)	29.4 % 5	0.0 % 0	0.0% 0
No Spin-Off (No)	70.6% 12	100.0% 9	100.0% 1
Total	100.0% 17	100.0% 9	100.0% 1

Chi-Square: 3.610

D.F.:2

Sig.: .165

Subtotal (n=27) 45%

In table 5b (I), the Chi-Square value of 3.610 is not significant and is indicative of the fact that commercial funding has an effect on the generation of spin-offs. Table 5b (I) showed that 29% (5) of professors who received commercial funding have some spin-offs based on their research. However, despite receiving commercial funding, 9 (100%) associate professors, and about 12 (71%) professors had no spin-off activity based on their research. Also, the assistant professor (100%) who received commercial funding has no spin-off based research. Nevertheless, the 29% (5) of professors whose research activities have generated a spin-off company can be considered as capitalizing knowledge by transforming their ideas into economic assets (Peterman, Harms, and Girard, 2001).

In table 5 b (II) below, despite the fact that the Chi-Square value of 1.742 is not significant at the .05 level, the results are still very interesting. It is worth noting that there is equally productive spin-off based research among faculty who have not received any commercial funding. For instance, two (17%) professors and an assistant professor (8%) have spin-off companies based on their research. If one compared table 5b (I) and table 5b (II), it is clear that whether you received commercial funding or not does not

guarantee a spin-off generated research. For instance, about 71% (12) of professors who received commercial funding (table 5b I) and about 83% (10) of those who did not receive commercial funding (table 5b II) have all not generated spin-off companies.

Table 5b (II): Effect of Rank on Spin-offs by Commercial Funding

(II) Subtitle: Ever Received Funding? No

Spin-Off Based Research?	RANK		
	Professor	Associate Professor	Assistant Professor
Spin-Off (Yes)	16.7 % 2	0.0 % 0	8.3% 1
No Spin-Off (No)	83.3% 10	100.0% 9	91.70% 11
Total	100.0% 12	100.0% 9	100.0% 12

Chi-Square: 1.742

D.F.:2

Sig.: .419

Subtotal: (n=33) 55%

Furthermore, none of the nine associate professors (100%) who received commercial funding and the nine who did not receive commercial funding (100%) reported any spin-off based research activity. Likewise, while about 92% (11) of assistant professors who did not receive any commercial funding did not produce any spin-off research, the one revealed in table 5 b (I) who received commercial funding has also not produced any spin-off based research. This is indicative of the fact that while commercial funding is important, it is not the sole reason for the production of spin-off generated knowledge. In a way, this is symptomatic of the normative and institutional changes in the regime of knowledge production and points to the fact that some academic scientists are increasingly no longer ready to sit idle thinking industrial scientists will take their basic research further.

The picture becomes clear when one looked at the data on intellectual property (IP) presented in table 5c below. Just as the data on spin-offs have shown, commercial funding is not a guarantee that an academic scientist will produce an IP based research. It is, therefore, not surprising that the IP data followed similar pattern as was the analysis based on the production of spin-off based research.

Table 5c: Effects of Commercial Funding of Research on IP innovation

Intellectual Property	Ever received Commercial Funding?	
	Yes	No
Zero IP	68.0 % 17	84.8 % 28
Between 1 to 10 IP	24.0% 6	15.2% 5
More than 10 IP	8.0% 2	0.0% 0
Total	100.0% 25	100.0% 33

Chi-Square: 3.748

D.F.:2

Sig.: .1154

(N= 58)

In table 5c, though the Chi-Square value of 3.748 is not significant, the data revealed the extent to which commercial funding affect IP production. As indicated by the responses in table 5c, among commercial funding recipients, about 24% (6) reported that they have been granted between one to ten IP rights, while about 8% (2) pointed out that they have been granted more than ten IP rights. Also, about 15% (5) of those who indicated that they did not receive commercial funding reported being granted between one to ten IP rights. However, about 85% (28) of non-commercial funding recipients and about 68% (17) of commercial funding recipients reported zero IP.

Consequently, just as the data on spin-offs have demonstrated some effect of commercial funding on academic scientists' ability to generate spin-off based research, the same is true of the production of IP based research. Therefore, based on the analysis in tables 5a, 5b and 5c, it is sufficient to conclude that the low level of knowledge capitalization is indicative of the performance of a blend of all the university's functions without any particular one necessarily overshadowing the others. It is also probable that the high percentage of non spin-off based research and the low number of granted IP rights are perhaps an indication of the emphasis on teaching. It may also be that academic scientists at the University of Saskatchewan are conducting relatively more basic than applied research.

Furthermore, it may be the case that most of the professors are engaged in contracting for consulting work. This is indicative of the *triple helix* model's assertion that academic research has been transformed making it possible for academic scientists to either engage in industrial research or conduct intermediary forms of research. These types of scientific activity involved research that is at the intersection of academia and industry (Shinn, 2002).

5.2.4 Capitalizing Knowledge: The Effect of Age

In addition to the role played by the *rank* of academic scientists and commercial funding in academic knowledge production and capitalization, the relationship between the age of academic scientists and spin-off generated research is explored. As shown in table 6 below, the Chi-square value of 3.337 is not statistically significant at the .05 level. While about four (29%) academic scientists born between 1940-1952 reported a spin-off

Table 6: Effect of Age on Spin-offs Generated Research

Spin-Off Based Research?	Age-cohorts		
	Cohort 1: 1940-1952	Cohort 2: 1953-1964	Cohort 3: 1965-1976
Spin-Off (Yes)	28.6 % 4	11.5 % 3	6.3% 1
No Spin-Off (No)	71.4% 10	88.5% 23	93.8% 15
Total	100.0% 14	100.0% 26	100.0% 16

Chi-Square: 3.337

D.F.:2

Sig.: .188

(N= 56)

generated research, only about three (12%) of those born within the 1953-1964 age-cohorts and one (6%) person who fall within the 1965-1976 age-cohorts detailed having a spin-off based research. However, about 94% (15) of academic scientists in the 1965-1976 age-cohorts, 89% (23) of those born between 1953-1964 and about 71% (10) of those in the 1940-1952 age-cohorts have all not reported any spin-off based research.

The findings in table 6 may perhaps be attributed to what has come to be known in academic circles as ‘publish or perish’. This partly explains why younger faculty seems to focus more on publication in the first few years for the purpose of tenure review and promotion. It also explains why they may be unwilling to work with commercial companies that may insert clauses preventing them from publishing their results until all patent applications are finalized. On the other hand, it may also be the result of the small sample size and the small-scale nature of academic knowledge capitalization at the University of Saskatchewan.

Consequently, the findings so far mirrored the idea of contradiction that comes with universities participation in the science-based knowledge economy. In post-normal

science, *contradiction* stresses the “co-existence of antagonistic forces, and provides a perspective which prevents oversimplified analysis of situations and problems” (Funtowicz and Ravetz, 1994:572). This, in post-normal science accounts make it impossible for one to “envisage a beneficial progress without looking for its costs...or the achievement of good without some production of evil” (Funtowicz and Ravetz, 1994:572). As such, the objective in terms of academic knowledge capitalization will be to look for those “elements that provide mutual reinforcement” (Tognetti, 1999:699).

Thus, the existence of traditional sources of funding and new partnerships with industry reinforces the innovation agenda that the *triple helix* model seeks to capture. The idea of innovation, not only “endogenizes the knowledge infrastructure of society as a next-order regime”, but emphasises the importance of values that knowledge users and producers share (Leydesdorff and Etzkowitz, 1997:157). In the next section, I built on the issues discussed here to further explore the perceptions of academic capitalization by turning attention to issues relating to privatization, intellectual autonomy and academic integrity.

5.3.0 Ideals and Contradictions in Academic Knowledge Capitalization

The debate over the transformation of academic knowledge landscape is at the heart of this study. Though the core elements of the *triple helix* are centered within the traditional university, the reach of the *triple helix* model goes beyond the university. As an interactive model, the *triple helix* recognizes the impact of evolving networks of internationalization, ICTs, and globalization as they feed back into the trilateral nodes of knowledge production (Leydesdorff and Etzkowitz, 2003c).

Though all types of knowledge are interest-laden, the idea of the neutrality of knowledge has been at the core of the debate about university-industry-government relations. The perception is that academic scientists who engaged in collaborative research with industry are inherently skewing research and scholarship in favour of industrial patrons, jeopardizes academic freedom, and above all infringes upon the idea of scientific neutrality. In fact, Habermas (1972) has long noted the interest basis of knowledge formation. Habermas, in his work *Knowledge and Human Interests* (1972), underscored the fact that scientific knowledge, physical, natural, social or critical theoretical is socially constructed and thus inherently attached to an interest. However, just as the elimination of interest was not crucial for him, in academic scientific knowledge production and capitalization, one can make the extension that what is crucial is not the source of funds but the way research problems are identified and framed.

In spite of this, James Turk (2000) argues that the growing dependence on private funding for university research not only shapes what gets studied but also invariably sets the academic research agenda. He went on to assert that the outcome of agenda-setting is the consequence of the fact that basic research is getting diminishing thought for lack of or nominal prospects in short-term commercial return. The study explores the perceptions of academic scientists about the setting of university research agenda. The academic faculty respondents were asked “whether private commercial companies have too much power to determine the university research agenda?”

As indicated by the responses in table 7, the majority of the respondents, that is, about 56% (33) are of the opinion that private commercial companies have the ‘right amount of power’. Only about 19% (11) indicated that commercial companies have ‘too

little power’ to determine and set the university research agenda. In fact, only about 12% (7) of the respondents were of the view that companies have ‘too much power’ and are determining the research agenda.

Table 7: Extent of Corporate Power in determining the Research Agenda

Corporate Influence	Frequency	Percentage (%)
Too much power	7	11.9
Right amount of power	33	55.9
Too little power	8	13.6
Can’t choose	11	18.6
Total	59	100.0

While, this issue is explored qualitatively in chapter six, the study further looked at the issue of corporate influence from the perspective of the *rank* of academic scientists’ vis-à-vis the setting of the research agenda. The Chi-square value of 13.054 for table 8a is significant at the .05 level. The results indicate an association between rank and the

Table 8a: The Perceptions of Corporate Influence by Rank

Corporate Influence	RANK		
	Professor	Associate Professor	Assistant Professor
Too much power	7.1% 2	11.1% 2	23.1% 3
Right amount of power	75.0% 21	44.4% 8	30.8% 4
Too little power	14.3% 1	16.7% 3	7.7% 1
Can’t choose	3.6% 1	27.8% 5	38.5% 5
Total	100.0% 28	100.0% 18	100.0% 13

Chi-square: 13.054

D.F.: 6

Sig.: .042

(N=59)

perceptions of corporate influence. In fact, about 23% (3) of assistant professors think companies have ‘too much power’ whilst only about 11% (2) of associate professors and

7% (2) of professors think likewise. This means that assistant professors, more than either full professors or associate professors perceived private commercial companies as having ‘too much influence’. This is understandable given that professors and associate professors are highly likely to have a longer working relationship with corporations than are most assistant professors. In spite of this, the majority of the respondents, that is about 75% (21) of professors, 44% (8) of associate professors, and about 31% (4) of assistant professors have all indicated that private commercial companies have the ‘right amount of power’. However, when one considers the response to the question whether corporations have ‘too little power’, professors account for about 14%, associate professors for about 17% and assistant professors for about 8%.

Though the data above is quite revealing, the high association between rank and corporate influence needs to be explored further to see if an intervening variable is at work. In order to do this, a control variable “ever received commercial funding” is introduced in the relationship between rank and corporate power to explain the underlining perception of corporate influence. As tables 8b (I) and 8b (II) detailed, the relationship between rank and corporate influence as a control variable ever received commercial funding is introduced into the relationship.

Table 8b (I) has a non-significant Chi-Square value of 5.425. It showed that among academic scientists who have received commercial funding, no one perceived private commercial companies to be wielding ‘too much power’. While there is no value to explain in terms of assistant professors when it comes to whether private commercial companies have the right amount of influence, about 75% (12) of professors and about

44% (4) of associate professors indicated that private commercial companies have the right amount of influence.

Table 8b (I): Perception of Corporate Influence by rank and commercial Funding

(I)Subtitle: Ever Received Commercial Funding? Yes

Corporate Influence	RANK		
	Professor	Associate Professor	Assistant Professor
Too much power	0.0 % 0	0.0 % 0	0.0% 0
Right amount of power	75.0% 12	44.4% 4	0.0% 0
Too little power	18.8% 3	33.3% 3	100.0% 1
Can't choose	6.3% 1	22.2% 2	0.0% 0
Total	100.0% 16	100.0% 9	100.0% 1

Chi-Square (Yes): 5.425

D.F.:4

Sig.: .246

Subtotal (n=26) 44.8%

Among the professoriate, about 100% of assistant professors, 33% of associate professors and about 19% of professors are likely to indicate that private commercial companies have 'too little power'. It is possible that the high percentage of professors who think private commercial companies have the 'right amount of power' may be due to their longer working relationship with industry, and also, their academic and administrative experiences.

A cursory look at table 8b (II) below showed that the Chi-Square value of 8.224 is not significant. However, among the non-commercial funding recipients, about 73% (8) of professors, 44% (4) of associate professors and about 33% (4) of assistant professors indicated that private commercial companies have the 'right amount' of influence.

Table 8b (II): Perception of Corporate Influence by rank and commercial Funding

(II) Subtitle: Ever Received Commercial Funding? No

Corporate Influence	RANK		
	Professor	Associate Professor	Assistant Professor
Too much power	18.2 % 2	22.2 % 2	25.0% 3
Right Amount of power	72.7% 8	44.4% 4	33.3% 4
Too little power	9.1% 1	0.0% 0	0.0% 0
Can't choose	0.0% 0	33.3% 3	41.7% 5
Total	100.0% 11	100.0% 9	100.0% 12

Chi-Square (No): 8.224

D.F.:6

Sig.: .222

Subtotal: (n=32) 55.2%

While among the non-commercial funding recipients only about 9% of professors thought corporate influence is ‘too little’, the most significant finding has to do with the response to “whether private commercial companies have too much influence”. It should be recalled that there was no value to report on among those who received commercial funding when table 8b (I) was discussed. However, among the non-commercial funding recipients (table 8b II), about 25% (3) of assistant professors, 22% (2) of associate professors and about 18% (2) of professors perceived private commercial companies to have ‘too much influence’.

It is quite interesting that in percentage terms, perception tends to move downwards as one’s rank move upwards. As such, there is the likelihood that academic scientists who have not received commercial funding but perceived private commercial companies as having ‘too much influence’ are likely to be assistant professors, followed

by associate professors and then full professors. As I have earlier noted, this is indicative of the fact that there is an inherent attitudinal transformation as one moved up the professorial ladder. It is also probable that as junior professors become established academics and move up in rank, they are in a better position to negotiate better funding contracts with private commercial companies, and as such, their levels of the perception of corporate influence dwindle.

The issue of corporate influence is further explored and the results detailed in table 9 below. Table 9 indicated a strong association between commercial funding and the perception of corporate influence. The Chi-Square value of 13.294 is significant at the

Table 9: Perception of Corporate Power by Commercial Funding¹⁰

Corporate Influence	Ever Received Commercial Funding?	
	Yes	No
Too much power	0.0 % 0	21.9 % 7
Right amount of power	61.5% 16	50.0% 16
Too little power	26.9% 7	3.1% 1
Can't Choose	11.5% 3	25.0% 8
Total	100.0% 26	100.0% 32

Chi-Square:13.294

D.F.:3

Sig.:.004

N=58

.01 level. The results showed that majority of academic scientists whether they received

¹⁰ It must be stated that when one controls for Rank, the relationship is similar to the ones explained above. Here only Professors are significant. This is possible due to the fact they are perhaps more experienced and have been enmeshed in most academic decisions and as such are well informed than their junior colleagues. Similarly, control for age-cohorts showed that only those born between 1953-1964 are more likely to view corporate influence to be the 'right amount'. This is perhaps due to the fact that 1953-1964 is a significant age cohort whereby, most academic scientists are at the prime of their careers.

commercial funding or not do not perceive private commercial companies as wielding too much influence to set the academic research agenda. In fact, while about 62% (16) of commercial funding recipients are likely to perceive corporate influence to be the right amount, about 50% (16) of non-commercial funding recipients are likely to concur. However, about 22% (7) of non-commercial funding recipients are likely to indicate that private commercial companies have ‘too much power’ to influence the academic research agenda. In the same way, the perception of corporate influence being ‘too little’ is higher among those who received commercial funding than it is among the non-commercial funding recipients. This again showed that commercial funding have a significant effect on how academic scientists perceived university-industry relations to be transforming the university.

In spite of this, the emerging trend is that academic scientists assumed they are in control of their research activities, and as such, they perceived private commercial companies more as partners than power brokers who have too much leverage to control and set the academic research agenda. I will further argue that the assertion that corporate funding of academic research is setting academic research agenda is a bit too simplistic. As we have just seen, the issue is far more complicated and variegated than often acknowledged. As Bourdieu (1984) has argued, knowledge is socially located in the contexts of power. Consequently, one cannot only use corporate research funding or perceptions of corporate power to conclude that private commercial companies are determining the research agenda. The university, as Bourdieu (1984:14) has noted, is a “self-preserving institution in which different kinds of power are produced, circulated and reproduced”. It is important to state that the argument being pursued here goes beyond

the critics of university—industry—government relations. It also relates to the problematic assumption inherent in the *triple helix* model that the three institutional nodes of knowledge production have parity in institutional power.

In practice, there are limiting factors, especially relating to the size of the sample presented in tables 8a, 8b (I) and 8b (II). However, based on Giddens' structuration concept, one can expand on the multiple basis of power in terms of 'rules' and 'resources'. In Giddens (1984) structuration theory, actors such as university scientists are 'knowledgeable' and readily draw upon rules and resources in diversity of action contexts. Actors in the production of interaction do not only use these rules and resources, but are themselves reconstituted during such interactions. Consequently, in spite of corporate power, university scientists in their research relations are simultaneously influencing corporate research and inevitably their funding decisions. So this transaction involves a give and take of relations in different contexts including economic, social and research. The reciprocal nature of power presupposes that in a given situation, an agent is able to chronically deploy a range of casual powers equal to or above those deployed by others. As a result, if power becomes unidirectional then academic scientists as agents may lose their capacity to 'make a difference' (Giddens, 1984:14).

The institutional cross-fertilization indicated by the *triple helix* model is at work in terms of the multiple basis of power (Etzkowitz and Leydesdorff, 1997). This means that universities are also transforming private commercial companies. Therefore, as corporations struggle for investment capital and for productive academic scientists, they are in turn imbibing various institutionalized practices that are associated with academia. This eventually results in corporations adopting and using "university-based conventions

such as academically-conferred prestige to fuel their pursuit of profit” (Kleinman and Vallas, 2001: 453).

Consequently, one should not lose sight of the fact that before recent increases in corporate funding, a significant amount of funds from philanthropic foundations and private individuals do come to the universities. As I have indicated elsewhere in this study, these Philanthropic Foundations were not disinterested charities. In fact, getting funding from the Rockefeller Foundation for instance, was contingent upon accepting an approach to research problems determined by science managers with their own agendas rather than that of an extended scientific peer community (Kohler, 1990).

5.3.1 The Effects of University-Industry Relations on Basic Science

Another contentious dimension of the debate about the setting of research agendas have to do with the issue of basic science. While it is clear that the fundamental nature of all sciences are basic, distinction often comes in when one wants to distinguish theoretical from applied science. The study seeks as one of its objectives to find out whether *triple helix* relations relegate what has been variously called basic or curiosity-driven research into the background.

Table 10a: Relegation of Basic Research to the Background

Response	Frequency	Percentage (%)
Agree	13	21.7
Neither agree nor disagree	15	25.0
Disagree	32	53.3
Total	60	100.0

As table 10a indicates, about 53% (32) of the academic scientists surveyed do not think that university-industry relations relegate curiosity-driven research into the

background. However, about 22% (13) of those surveyed were of the opinion that basic research is being relegated to the background.

Table 10b: Relegation of Basic Research by Commercial Funding of University Research?

Basic Research relegated into the Background?	Ever received Commercial Funding?	
	Yes	No
Agree	18.5 % 5	21.9 % 7
Neither agree nor Disagree	14.8% 4	34.4% 11
Disagree	66.7% 18	43.8% 14
Total	100.0% 27	100.0% 32

Chi-Square:3.703

D.F.:2

Sig.: .157

N=59

In table 10b, though the Chi-Square value of 3.703 is not statistically significant at the .05 level, the data revealed some interesting insights about the effect of commercial funding on the perceptions of academic scientists. The data showed that among commercial funding recipients, about 67% (18) are likely to ‘disagree’ with the assertion that commercial funding of academic research is relegating basic research into the background. For the non-commercial funding recipients, about 44% (14) are likely to indicate that basic research is not being relegated into the background. However, it is interesting to note that those who did not receive commercial funding (22%) are more likely than those who received commercial funding (19%) to agree that basic research is being relegated to the background.

It is clear that commercial funding influences perception when it comes to the question of whether basic research is being relegated to the background or not. These

findings are not different from what Blumenthal (1986) and his collaborators found in their study of biotechnology faculty. However, one must acknowledge that the 22% (7) of non-commercial funding recipients who think that basic research is being relegated to the background deserve to be taken seriously no matter how small their numbers are in proportionate terms. Their perceptions lend credence to the assertion made by Turk (2000) to the effect that basic research is getting diminishing thought for lack of short-term commercial return. They also furthered the observation that it will be “naïve of academics today to assume that universities would be supported or enrolled at current levels if the institutions were stripped of their economic role in favour of an exclusively cultural one” (Axelrod, 2002:31).

5.3.2 The Perceptions of the Influence of Economic Criteria in the allocation of Institutional Resources: The Perspective of Academic Rank

Linked to the issue of the relegation of basic science into the background is the idea that the outcomes of university—industry relations makes economic criteria¹¹ hold sway over academic criteria and actual departmental needs in the allocation of institutional resources. The argument is that the resource a college or department gets is dependent upon whether its professors are able to attract significant grants from external sources or not. In order to explore this practice and understand the underlying rationale, the study examines the relationship between the rank of academic scientists and the criteria for institutional resource allocation. As table 11a indicated, the Chi-square value of 13.043 is significant at the .01 level. It showed that junior professors are more likely

¹¹ The context in which the term ‘economic criteria’ is used in this study is based on the ability of a professor to source for external funds from granting or industrial sources. It does not refer to whether the college or department has the budget to hire or not.

than their senior colleagues to assert that economic rather than academic criteria are the dominant factor in institutional resource allocation.

Table 11a: Criteria for the allocation of Institutional Resources by Rank

Institutional Resource Allocation	RANK		
	Professor	Associate professor	Assistant Professor
Agree	30.0% 9	61.1% 11	76.9% 10
Neither agree nor disagree	23.3% 7	22.2% 4	23.1% 3
Disagree	46.7% 14	16.7% 3	0.0% 0
Total	100.0% 30	100.0% 18	100.0% 13

Chi-square: 13.043

D.F.: 4

Sig.: .011

(N=61)

In fact, about 77% (10) of assistant professors, 61% (11) of associate professors and about 30% (9) of professors noted that economic criteria are much more prominent in the allocation of institutional resources than are academic criteria. In addition, identical proportion of all academic scientists, whether full professors (23%), associate professors (22%) or assistant professors (23%) could ‘neither agree nor disagree’ as to the extent of the influence of economic criteria in institutional resource allocation. However, about 47% (14) of professors and 17% (3) of associate professors ‘disagree’ that economic rather than academic criteria hold sway when it comes to the allocation of institutional resources. This is significant especially as there were no respondents among assistant professors who ‘disagree’ with this assertion.

It is important for one to add that economic criteria does not mean that private commercial companies are necessarily determining the way resources are deployed in the

university. But it is highly possible that this has to do with the adoption of corporate management practices by university administrators. There is the need as a result of the high association between rank and institutional resource allocation to statistically control for the relationship to see which other underlining factors are at work. As such, the analysis based on table 11b (I&II) is meant to explain the outcomes of the effect of the control variable—whether an academic scientist received commercial funding or not.

Table 11b (I): Perception of the Influence of Economic Criteria in Institutional Resource Allocation by Rank and Commercial Funding

(I) Subtitle: Ever Received Funding? Yes

Institutional Resource Allocation	RANK		
	Professor	Associate Professor	Assistant Professor
Agree	29.4 % 5	66.7 % 6	0.0% 0
Neither agree nor Disagree	29.4% 5	22.2% 2	100.0% 1
Disagree	41.2% 7	11.1% 1	0.0% 0
Total	100.0% 17	100.0% 9	100.0% 1

Chi-Square (Yes): 6.369

D.F.:4

Sig.: .173

Subtotal (n=27) 45%

The Chi-Square value of 6.369 is not significant at the .05 level. In spite of this, table 11b (I) showed that among academic scientists who received commercial funding, 67% (6) of associate professors and about 29% (5) of professors perceived the allocation of institutional resources as being determined by economic rather than academic criteria. In addition, while about 41% of professors ‘disagree’ with the assertion that economic criteria hold sway when it comes to the allocation of institutional resources, only about 11% of associate professors perceived the issue in a similar manner. It should be noted

that there is no significant value to report from the perspective of assistant professors. But the findings in table 11b (I) are interesting in that the junior professors are more likely to perceive economic criteria as influencing institutional resource allocation than are senior professors. This again revealed an attitudinal transformation in that as an academic scientist climbed up the professorial ladder his/her views regarding the allocation of institutional resources become largely moderated. As such, there is a significant shift from a very strong agreement to a strong disagreement. This finding is mirrored by the responses from those who have not received commercial funding presented in table 11b (II) below.

Table 11b (II): Perception of the Influence of Economic Criteria in Institutional Resource Allocation by Rank and Commercial Funding

(II) Subtitle: Ever Received Funding? No

Institutional Resource Allocation	RANK		
	Professor	Associate Professor	Assistant Professor
Agree	25.0 % 3	56.6 % 5	83.3% 10
Neither agree nor Disagree	16.7% 2	22.2% 2	16.7% 2
Disagree	58.3% 7	22.2% 2	0.0% 0
Total	100.0% 12	100.0% 9	100.0% 12

Chi-Square (No): 11.458

D.F.:4

Sig.: .022

Subtotal: (n=33) 55%

In table 11b (II) the Chi-Square value of 11.458 is not significant at the .05 level. However, its results are quite similar to the trend found among the recipients of commercial funding. Among academic scientists who have not received commercial funding, about 83% (10) of assistant professors, 57% (5) of associate professors and

about 25% (3) of professors are likely to perceive economic criteria as having a greater role to play in the allocation of institutional resources than academic criteria. The result showed a decline in perception of the influence of economic criteria in institutional resource allocation as one moved from assistant to associate and then to professor.

On the other hand, the reverse holds when one considers the category ‘disagree’. Here, while there is no value to comment on among assistant professors, only about 22% (2) of associate professors compared to about 58% (7) of professors stated that economic criteria do not hold sway when it comes to the allocation of institutional resources. Again, a critical look at tables 11b (I) and 11b (II) revealed that associate and professors who received commercial funding are more likely to perceive economic criteria as determining the institutional allocation of resources than their counterparts who have not received any commercial funding. This is perhaps due to self gratification and the feeling of an accomplishment since the term economic criteria broadly defined denotes a professor’s ability to source for external funds to supplement his/her departmental resources.

Apart from the above reasoning, it is also plausible that the perceptions that economic criteria are determining the allocation of institutional resources have to do with the translation of the number of students who enrolled in a particular college or department into tuition dollars, which invariably affects the allocation of institutional resources. This is indicative of the argument that there is a new mechanism of knowledge production—Mode 2 (Gibbons et al. 1994), and that these transformations have resulted in what can be termed the second academic revolution (Etzkowitz, 2002). Gibbons et al. (1994) argued that in the new Mode 2, knowledge production becomes part of a larger

process in which discovery, application, and use are closely integrated. In their view, the new Mode 2 brings to the forefront an environment in which there is both competition and teamwork and the constant reconfiguration of resources, knowledge and skills (Gibbons et al. 1994).

My understanding from informal conversations with various respondents is that as student enrolment in a particular college/department goes down so does the capital allocated to the college/department. Thus departments have to rely on grants that faculty can bring in from both the Tri-Council granting agencies and industrial partners. So in effect, the issue of funds seems to be a general problem across campus. However, since the knowledge-based economy is based more on cutting edge transformative technologies, the Humanities and the Social Sciences whose research endeavours focused more on basic rather than applied research may feel the impact more than other colleges.

It is clear that the dwindling of funds from traditional sources is at the heart of the funding constraints. This has necessitated the university to adopt cost-cutting measures. The declining funds have affected not only the university but also other spheres of institutional knowledge production. In *triple helix* terminology, a recursive effect on the inter-institutional networks representing academia-industry-government and larger society has resulted (Etzkowitz et al., 2000). As such, for universities to adjust to these transformations, discipline-based departments must converge in new ways whilst maintaining traditional lines of research (Shinn, 2002). Simultaneously, there should be the recognition that there would be benefits as well as costs for the university as it turns to industrial and intermediary forms of research in order to make up for the shortfalls in government funding.

5.3.3 The Perceptions of the Influence of Economic Criteria in the allocation of Institutional Resources: The Perspective of Academic Age

The allocation of institutional resources becomes more revealing when one explores the association between the age-cohorts of academic scientists vis-à-vis the role of economic and academic criteria in the allocation of institutional resources. As shown in table 12a, the Chi-square value of 9.016 is not significant at the .05 level. It is clear that 69% (11) of academic scientists who fall within 1965-1976 age-cohorts, about 46% (12) those born between 1953-1964 and about 33% (5) of those within 1940-1952 age-cohorts are more likely to indicate that economic criteria are determining which college/department gets what institutional resources. This suggests that academic scientists who are relatively younger perceived economic criteria to be determining the allocation of institutional resources than their relatively older counterparts.

Table 12a: Perception of the Influence of Economic Criteria in Institutional Resource Allocation by Age

Institutional Resource Allocation	Age-cohorts		
	Cohort 1: 1940-1952	Cohort 2: 1953-1964	Cohort 3: 1965-1976
Agree	33.3 % 5	46.2 % 12	68.8% 11
Neither agree nor Disagree	13.3% 2	26.9% 7	25.0% 4
Disagree	53.3% 8	26.9% 7	6.3% 1
Total	100.0% 15	100.0% 26	100.0% 16

Chi-Square:9.016

D.F.:4

Sig.:.061

N=57

However, when one looked closely at those who ‘disagree’ with this assertion, about 53% of those born between 1940-1952, 27% of individuals who fall within 1953-

1964 age-cohorts and about 6% of those born between 1965-1976 are likely to differ that economic criteria are determining the allocation of institutional resources. In terms of the neutral category 'neither agree nor disagree,' about 27% of those who fall within the 1953-1964 age-cohorts, 25% of those born between 1965-1976 and about 13% of those within the 1940-1952 age-cohorts have all expressed similar sentiments about the allocation of institutional resources. Once again, it is obvious that the analysis based on age-cohorts and institutional resource allocation is not considerably different from the preceding one based on *rank*.

It is clear from table 12a that as academic scientists advanced in age, their perceptions of the dominance of economic criteria in institutional resource allocation declined. This is reflected by the decline in those who 'agree' that economic criteria determined institutional resource allocation from about 69% to about 46% and then to about 33%. Simultaneously, there is an increase in the disagreement with the assertion that economic criteria hold sway when it comes to the allocation of institutional resources. This is also explained by the shift from about 6% to 27% and then to about 53%. This may be due to the persistent call in the past three decades on the universities by governments and industries to translate their abundant knowledge into economic good to benefit society. It is, therefore, conceivable that these nuances have made their way into university recruitment and administrative policies, which invariably have filtered into the social fabric of the younger generation of professors.

It is also plausible that as academic scientists advance within academia and begin to take up more administrative duties, they tend to become aware of the larger picture and are more likely to fully understand the factors that go into making decisions about which

college or department get what institutional resources. However, due to the high association between age and institutional resource allocation, there is the need to statistically control for the relationship to see which other underlining factor other than age is significantly affecting perception of institutional resource allocation. As such, tables 12b (I) and 12b (II) explored these relationships introducing a control variable—whether an academic scientist received commercial funding or not.

Table 12b (I): Perception of the Influence of Economic Criteria in Institutional Resource Allocation by Age and Commercial Funding

(I) Subtitle: Ever Received Funding? Yes

Institutional Resource Allocation	Age-cohorts		
	Cohort 1: 1940-1952	Cohort 2: 1953-1964	Cohort 3: 1965-1976
Agree	33.3 % 3	44.4 % 4	33.3% 2
Neither agree nor Disagree	22.2% 2	22.2% 2	50.0% 3
Disagree	44.4% 4	33.3% 3	16.7% 1
Total	100.0% 9	100.0% 9	100.0% 6

Chi-Square (Yes): 2.209

D.F.:4

Sig.: .697

Subtotal (n=24) 42.9%

When one controls for the relationship between the age-cohorts and institutional resource allocation by introducing commercial funding, the Chi-Square value of 2.209 for table 12b (I) is not significant at the .05 level. This showed that the relationship between age and institutional resource allocation is affected by the receipt or otherwise of commercial funding. The data presented in table 12b (I) revealed that among academic scientists who received commercial funding, about 33% (2) of those born between 1940-

1952, 44% (4) of those who fall within the 1953-1964 age-cohorts and about 33% (2) of those born between 1965-1975 are likely to perceive economic criteria as influencing the allocation of institutional resources. Also, about 17% (1) of those born between 1965-1976, 33% (3) of those within the 1953-1964 age-cohorts and about 44% (4) of those born between 1940-1952 are likely to ‘disagree’ that economic criteria are paramount when it comes to the allocation of institutional resources. The analysis once again revealed an increasing trend in that as academic scientists advanced in age and perhaps become more experienced professionally, their perceptions that institutional resource allocation is largely determined by economic criteria receded giving way to the consideration of other factors.

Table 12b: Perception of the Influence of Economic Criteria in Institutional Resource Allocation by Age

(II) Subtitle: Ever Received Funding? No

Institutional Resource Allocation	Age-cohorts		
	Cohort 1: 1940-1952	Cohort 2: 1953-1964	Cohort 3: 1965-1976
Agree	20.0 % 1	47.1 % 8	90.0% 9
Neither agree nor Disagree	0.0% 0	29.4% 5	10.0% 1
Disagree	80.0% 4	23.5% 4	0.0% 0
Total	100.0% 5	100.0% 17	100.0% 10

Chi-Square (**No**): 14.390

D.F.:4

Sig.: .006

Subtotal: (n=32) 57.1%

However, when one considers the second part of the control variable, the non—recipients of commercial funding—table 12b (II)—the Chi-Square value of 14.390 is

significant at the .01 level. Table 12b (II) indicated that among non-commercial funding recipients, 90% (9) of academic scientists born between 1965-1975, 47% (8) of those born between 1953-1964 and about 20% (1) of those within the 1940-1952 age-cohorts are likely to perceive economic criteria as holding sway over academic criteria when it comes to the allocation of institutional resources. Also, among the non-commercial funding recipients, about 24% (4) of those within 1953-1964 age-cohorts and about 80% (4) of those born between 1940-1952 have all 'disagreed' with the assertion that economic criteria are dominant when it comes to the allocation of institutional resources.

While, the small sample-size is a limiting factor in explaining what actually is going on, it is clear that whether an academic scientist received commercial funding or not affects his perception of the allocation of institutional resources. Based on the above insightful but interacting findings, the issues of the influence of economic criteria are further explored in the next section using three age related bivariate tables—13a, 13b (I) and 13b (II). However, the focus of the discussion shifts from resource allocation to academic faculty recruitment.

5.3.4 The Perceptions of the influence of Economic Criteria in Faculty Recruitment

Interestingly, when one explored the extent to which economic criteria are determining the recruitment of faculty, most respondents indicated that this is not a major influence at the University of Saskatchewan. Respondents were asked to choose from a five point Likert scale, which was later recoded into three categories. The question asked was whether the recruitment of academic faculty is based on the ability to attract corporate research dollars? This question is detailed in table 13a below. In this analysis,

the relationship between the age-cohorts of academic scientists and their perceptions of the influence of economic criteria in faculty recruitment is explored. The Chi-Square value of 8.963 is not significant at the .05 level.

Table 13a: Perception of the Influence of Economic Criteria in Faculty Recruitment by Age

Influence of Economic Criteria in Faculty Recruitment	Age-cohorts		
	Cohort 1: 1940-1952	Cohort 2: 1953-1964	Cohort 3: 1965-1976
Agree	20.0 % 3	11.5 % 3	37.5% 6
Neither agree nor Disagree	20.0% 3	26.9% 7	43.8% 7
Disagree	60.0% 9	61.5% 16	18.8% 3
Total	100.0% 15	100.0% 26	100.0% 16

Chi-Square:8.963

D.F.:4

Sig.:.062

N=57

In table 13a, about 38% (6) of those born between 1965-1976, 12% (3) of those who fall within the 1953-1964 age-cohorts and about 20% (3) of those born between 1940-1952 have all agreed with the assertion that economic criteria are dominant when it comes to academic faculty recruitment. Also, about 44% (7) of those in the 1965-1975 age-cohorts, 27% (7) of those who fall within the 1953-1964 age-cohorts and about 20% (3) of those born between 1940-1952 could ‘neither agree nor disagree’ with the assertion that economic factors are the most important when it comes to faculty recruitment. However, about 19% (3) of those born between 1965-1976, 62% (16) of those who fall within 1953-1964 age-cohorts and about 60% (9) of those born between 1940-1952 have all ‘disagreed’ that economic factors are paramount when it comes to faculty recruitment.

While the .06 statistically non-significance level of table 13a means the relationship should be assessed with moderation, it is still prudent to statistically control for the relationship. As such, tables 13b (I) and 13b (II) explored this relationship by introducing a control variable—whether an academic scientist received commercial funding or not.

Table 13b (I): Perception of Economic Criteria in Faculty Recruitment by Age and Commercial Funding

(I) Subtitle: Ever Received Funding? Yes

Influence of Economic Criteria in Faculty Recruitment	Age-cohorts		
	Cohort 1: 1940-1952	Cohort 2: 1953-1964	Cohort 3: 1965-1976
Agree	22.2 % 2	22.2 % 2	50.0% 3
Neither agree nor Disagree	11.1% 1	22.2% 2	50.0% 3
Disagree	66.7% 6	55.6% 5	0.0% 0
Total	100.0% 9	100.0% 9	100.0% 6

Chi-Square (**Yes**): 7.201

D.F.:4

Sig.: .126

Subtotal (n=24) 42.9%

In table 13b (I), the Chi-Square value of 7.201 is not significant at the .05 level. It indicated that among academic scientists who received commercial funding, about 50% (3) of those who fall within 1965-1976 age-cohorts, about 22% (2) of those born between 1953-1964 age-cohorts and about 22% (2) of those born between 1940-1952 perceived economic criteria as holding sway when it comes to the academic faculty recruitment. On the other hand, when one considers commercial funding recipients who ‘disagree’, about 67% (6) of those within 1940-1952 age-cohorts and 56% (5) of those within 1953-1964 age-cohorts have all ‘disagree’ that economic criteria are the overriding factors when it

comes to faculty recruitment. This showed that the relatively younger professors' perceptions of economic factors in the faculty recruitment process are stronger than their relatively senior counterparts. This might probably be the outcome of the increased nuances about the emergence of a science-based knowledge economy. In other words, the consequence of economic globalization is that politicians and administrators have tended to talk and act more towards the university as an uncharted knowledge bank into which the country must forage to accelerate economic competitiveness and socio-economic well being of society.

Table 13b (II): Perception of Economic Criteria in Faculty Recruitment by Age and Commercial Funding

(II) Subtitle: Ever Received Funding? No

Influence of Economic Criteria in Faculty Recruitment	Age-cohorts		
	Cohort 1: 1940-1952	Cohort 2: 1953-1964	Cohort 3: 1965-1976
Agree	20.0 % 1	5.9 % 1	30.0% 3
Neither agree nor Disagree	20.0% 1	29.4% 5	40.0% 4
Disagree	60.0% 3	64.7% 11	30.0% 3
Total	100.0% 5	100.0% 17	100.0% 10

Chi-Square (**No**): 4.363

D.F.:4

Sig.: .359

Subtotal: (n=32) 57.1%

In table 13b (II), among academic scientists who have not received commercial funding, about 30% (3) of those born between 1965-1976, 6% (1) of those in the 1953-1964 age-cohort, and about 20% (1) of those who fall within the 1940-1952 age-cohort are more likely to 'agree' that economic criteria are the major factor when it comes to

faculty recruitment. The majority of non-commercial funding recipients do not perceived economic criteria to be the major determinant of faculty recruitment. In this regard, about 30% (3) of those within 1965-1976 age-cohorts, about 65% (11) of those within 1953-1964 age-cohorts and about 60% (3) of those born between 1940-1952 are likely to disagree with the assertion that economic criteria are the major factors when it comes to faculty recruitment.

It is clear that though it appears that whether one receives commercial funding or not has an influence on the way one perceives economic criteria to influence faculty recruitment, as tables 13b (I) and 13b (II) have shown, only about 43% of this perception can be explained as having to do with the influence of the receipt of commercial funding. As such, about 57% of the perceptions of the influence of economic criteria in faculty recruitment can be explained by the influence of not receiving commercial funding. In spite of this, the analysis has so far shown that those who received commercial funding have a slightly positive perception of the influence of economic factors than their counterparts who have not received commercial funding. Therefore, its possible that the steady increase in corporate funding and the overall growth of university-industry-government relations as it relates to research funding is not necessarily pre-determined in favour of either private corporations or the state, nor is it necessarily at the expense of the university.

5.3.5 'Privatization' of the University through Industrial use of Facilities

Since academic scientists have long history of working relationships with industry, efforts to rigidly police the boundary separating basic and applied research have not deterred those who are willing to go beyond the production of knowledge for its intrinsic

value. This has, however, provided some critics (see Axelrod, 2000; Turk, 2000; Polster, 2000; Woodhouse, 2003) with a significant impetus to argue that the intensification of research collaboration with industry and the use of university facilities by private commercial companies are leading to the privatization of the university. This study tried to ascertain the extent to which academic scientists perceive the use of university facilities by private commercial companies as leading to the ‘privatization’ of the university.

Table 14a: Industrial use of University facilities leads to Privatization?

University Privatized?	Ever Received Commercial Funding?	
	Yes	No
Agree	7.7 % 2	34.4 % 11
Neither agree nor Disagree	30.8% 8	12.5% 4
Disagree	61.5% 16	53.1% 17
Total	100.0% 26	100.0% 32

Chi-Square:7.049

D.F.:2

Sig.:.029

N=58

In table 14a, the Chi-Square value of 7.049 is significant at the .05 level. It is clear that whether one receives commercial funding or not have a considerable effect on his/her perception of industrial use of university facilities. The data presented in table 14a showed that about 62% (16) of academic scientists who received commercial funding ‘disagree’ that the industrial use of university facilities is leading to the privatization of the university. The corresponding figure among non-commercial funding recipients is about 53% (17). Also, while only about 8% (2) of commercial funding recipients

perceived industrial use of university facilities as leading to the privatization of the university, the result among non-commercial funding recipients is about 34% (11). It is clear that the perceptions of academic scientists of the industrial use of university facilities are moderated by the receipt or non-receipt of commercial funding.

Since the association between the receipt or otherwise of commercial funding and the privatization of the university through industrial use of university facilities is so strong, there is the need to introduce a control variable. The control variable in this case is the *rank* of academic scientists.

Table 14b (I): Industrial use of University facilities leads to Privatization by Rank

(I) Subtitle: What is your Rank? Professor

University Privatized?	Ever Received Commercial Funding?	
	Yes	No
Agree	6.3 % 1	16.7 % 2
Neither agree nor Disagree	60.0% 3	40.0% 2
Disagree	75.0% 12	66.7% 8
Total	100.0% 16	100.0% 12

Chi-Square (**Professor**): .778

D.F.:2;

Sig.: .678

Subtotal (n=28) 48.3%

The first of the controlled analysis is table 14b (I). Though the Chi-Square value of .778 is not significant, the finding does mirror that of table 14a. For instance, among commercial funding recipients who are professors, only about 6% agreed that industrial use of university facilities are leading to the privatization of the university. Also, about 17% (2) of professors who have not received commercial funding are likely to hold

similar perceptions. In addition, while about 67% (8) of professors who have not received commercial funding are likely to ‘disagree’ that the industrial use of facilities are leading to the privatization of the university, the percentage response among commercial funding recipients who think likewise is 75% (12). This showed that whether a professor received commercial funding or not has a significant influence on his/her perception of the outcome of the industrial use of university facilities. The findings in table 14b (I) are not significantly different from those reported in table 14b (II) below.

Table 14b (II): Industrial use of University facilities leads to Privatization by Rank

(II) Subtitle: What is your Rank? Associate Professor

University Privatized?	Ever Received Commercial Funding?	
	Yes	No
Agree	11.1 % 1	33.3 % 3
Neither agree nor Disagree	44.4% 4	11.1% 1
Disagree	44.4% 4	56.6% 5
Total	100.0% 9	100.0% 9

Chi-Square (**Associate Professor**): 2.911

D.F.:2

Sig.: .233

Subtotal (n=18) 31.0%

The Chi-Square value of 2.911 is not significant. However, it did reveal that the relationship between private commercial funding and privatization of the university through industrial use of facilities is not the only factor accounting for perception. Table 14b (II) showed that one (11%) commercial funding recipient who is an associate professor perceived the industrial use of university facilities as leading to the privatization of the university. This perception is three times higher among his rank

colleagues (33%) who have not received commercial funding. In addition, while about 44% (4) of associate professors who received commercial funding are likely to ‘disagree’ that industrial use of facilities are leading to the privatization of the university, about 57% (5) of those who have not received commercial funding are likely to hold similar perceptions.

Table 14b (III): Industrial use of University facilities leads to Privatization by Rank

(III) Subtitle: What is your Rank? Assistant Professor

University Privatized?	Ever Received Commercial Funding?	
	Yes	No
Agree	0.0 % 0	54.5 % 6
Neither agree nor Disagree	100.0% 1	9.1% 1
Disagree	0.0% 0	36.4% 4
Total	100.0% 1	100.0% 11

Chi-Square (**Assistant Professor**): 5.455

D.F.:2

Sig.: .065

Subtotal (n=12) 20.7 %

However, when one considers the results of the third controlled variable, table 14b (III)—assistant professors, the Chi-Square value of 5.455 is not significant at the .05 level. The data in table 14b (III) showed that about 55% (6) of assistant professors who have not received commercial funding perceived the industrial use of university facilities to be leading to the privatization of the university. This is consistent with tables 14b (I) and 14b (II) despite the fact that it is difficult to draw a definite conclusion based on table 14b (III) as a result of the fact that certain cells have very few values.

In spite of this, the results are indicative of the fact that there is an ongoing attitudinal transformation among the professoriate. As such, as one gains more administrative and professorial experience by rising through the ranks, his attitude toward university-industry collaboration is affected as well. It is clear from tables 14b (I), 14b (II) and 14b (III) that when rank is controlled for, the perceptions of academic scientists regarding the consequences of industrial use of university facilities are affected by the receipt or non receipt of commercial funding. This incidence is about 48% among professors, about 31% among associate professors and about 21% among assistant professors. This is symptomatic of the fact that while commercial funding is important in perception formation regarding university-industry cooperation, it is not the sole factor.

Consequently, the growing notion that academic capitalism is harming the core functions of the university and leading to the privatization of the university is a bit simplistic. Hence, one can conclude to a greater measure that the sourcing of private funding for academic research and the use of academic facilities by private commercial companies does not necessarily lead to the conversion of knowledge into a private good. As Simmel ([1907] 1978) argued, the contested character of knowledge in practical circumstances is often repressed but the unrestricted potential is its availability.

5.3.6 The impact of University-Industry Relations on the Perception of Intellectual Autonomy

Apart from the privatization of knowledge, intellectual autonomy is another important issue in the debate about the production and capitalization knowledge. The issue of autonomy is usually linked to the issue of academic freedom. In the Canadian context, it has been noted that the history of academic freedom is partly the account of a

relatively small number of professors who, in expressing their professional or personal views, found themselves at odds with received wisdom in religion, morality, business, economic, politics, or university government (Horne, 2001). Horne (2001) noted that academic freedom is most threatened today by the demand that universities become more businesslike or market driven. His main concern, which is necessary and legitimate, has to do with the misconception about the value of the marketplace for the university. As I have argued elsewhere in this thesis, academic capitalism is not a panacea for all the problems of the university. To explore this issue, the study asked academic scientists their opinion on the link between commercial-sponsored research and intellectual autonomy.

Table 15: Effect of private commercial company sponsored research on Intellectual Autonomy

Loss of Intellectual Autonomy	RANK		
	Professor	Associate professor	Assistant Professor
Agree	10.3% 3	27.8% 5	30.8% 4
Neither agree nor disagree	37.9.3% 11	22.2% 4	38.5% 4
Disagree	51.7% 15	50.0% 9	30.8% 4
Total	100.0% 29	100.0% 18	100.0% 13

Chi-square: 4.509

D.F.: 4

Sig.: .341

(N=60)

Though the Chi-Square value of 4.509 is not statistically significant at the .05 level, the results nevertheless helped us to explore the extent to which academic rank influences perceptions about the effect of commercial-sponsored research on intellectual autonomy. The results in table 15 showed that about 31% (4) of assistant professors and

about 28% (5) of associate professors are of the opinion that university scientists who conduct private commercial-sponsored research are surrendering their intellectual autonomy to these influential patrons. Interestingly, only about 10% (3) of professors think likewise. However, when one considers the relations in terms of those who disagree, about 52% (15) professors, 50% (9) associate professors, and 31% (4) assistant professors all differ with the assertion that university scientists who conduct private commercial company sponsored research are surrendering their intellectual autonomy. It is quite remarkable that the number of assistant professors who agree (31%) that university scientists who conduct private commercial company sponsored research are surrendering their intellectual autonomy to these influential patrons exactly equals the numbers that disagree (31%). This is quite revealing because it indicates that these links are perhaps insights and are possibly due to the type of research one is pursuing and with whom.

In addition, there is also a generational gap in that the understanding of the effect of university-industry collaborative research seems to vary according to rank. This may be due to changing socio-economic and political dynamics. As such, it becomes important when considered in light of Karl Mannheim's assertion that the "ideas that people hold vary with changing economic circumstances" since the ideas are "somehow connected with the social context in which they live" (Zeitlin, 1996:338).

In spite of this, there is no statistically significant association between rank and whether scientists who conduct private commercial company research are surrendering their intellectual autonomy to their patrons as shown by the data presented in table 15 above. However, since it is a major objective of this study is to understand both formal and informal factors effecting the perception of academic scientists in terms of academic

knowledge production and capitalization there is the need to explore the link between commercial funding and intellectual autonomy. The question that table 16 below intends to unmask is whether commercial funding of university research leads to the loss of intellectual autonomy. The Chi-Square value of 6.013 for table 16 is significant at the .05 level.

Table 16: Commercial Funding of University Research leads to loss of Intellectual Autonomy?

Loss of Intellectual Autonomy?	Ever Received Commercial Funding?	
	Yes	No
Agree	11.5 % 3	24.2 % 8
Neither agree nor Disagree	23.1% 6	42.4% 14
Disagree	65.4% 17	33.3% 11
Total	100.0% 26	100.0% 33

Chi-Square: 6.013

D.F.:2

Sig.:.049

N=59

The result showed that about 12% (3) of commercial funding recipients and about 24% (8) of non-commercial funding recipients agreed that commercial funding of university research is leading to the loss of intellectual autonomy. The majority of those surveyed, that is, about 65% (17) of commercial funding recipients ‘disagree’ with the assertion that their collaborative work with commercial funding agencies is leading to the loss of intellectual autonomy. For the non-commercial funding recipients, only about 33% (11) ‘disagree’ with the assertion that academic scientists who conduct industrial sponsored research are surrendering their intellectual autonomy to these partners. It is, once again apparent, that commercial funding has a significant effect on the perceptions

of academic scientists regarding the loss of intellectual autonomy. This presupposes that there are risks either real or potential that must be resolved. However, in assessing this revelation, one must be guided by the fact that implicit conclusions cannot be drawn from this without stretching facts beyond their limits. The need to avoid exaggeration is important. This is because we cannot “assume that just because a researcher is paid by a particular sponsor, the researcher will abandon his or her scholarly integrity to favour the sponsor” (Renke, 2000:33).

Though the study revealed that commercial funding impacts the perception of the loss of intellectual autonomy, it is not at all clear that intellectual autonomy is being surrendered to industrial partners. This notwithstanding, in the literature, it seems that this conclusion tends to depend on which side of the debate one pitches camp. For instance, Graham has stated that the “bias of money steers research topics as well as methods, and since university teaching is so closely tied to research, it steers teaching programs and course contents as well” (2000:26). Based on these conjectures, he concluded that the “commercialization of knowledge in the present context is emphatically not in the public interest” (Graham, 2000:26). Slaughter and Rhoades (1990) also declared that industry-university relations have undermined the autonomy of knowledge, academic freedom, and have as a consequence, reinforced the hierarchical structure of universities by giving control to central administrations.

However, in my opinion, the above results only signify the changing landscape of academic knowledge production, which is based on continuity and change. There is continuity in the sense that the university has retained its fundamental aims and goals even as it has expanded its purview to encompass new missions. The continuity of the

university resides in its history of development “each new task has evolved out of an effort to meet a previous goal” (Etzkowitz, 2002:10). Thus the most distinctive change has to do with the fact that at the University of Saskatchewan about 45% (table 3) of academic faculty in the physical, engineering and life sciences are receiving funding from private commercial sources unlike the past when all their funds came from government sources. This shift particularly in the Canadian context is reflected in the goals and priorities of the Science Council of Canada. While acknowledging the need to preserve the traditional roles of teaching and research, they simultaneously call upon universities to help promote Canadian interests in the science-based knowledge economy. As they put it the “intellectual resources of the university are needed to help revitalize mature industries and generate the product ideas needed to create new ones (Science Council of Canada 1987:17).

While, the need to integrate academia and industry is necessary, the problem that must be underscored in any debate on universities roles in the science-based knowledge economy has to do with tacit knowledge. Do we have to pursue capitalizable knowledge at the peril of other knowledges? It is encouraging that the Science Council of Canada underscores the importance of this question by admitting that Canada’s “future prosperity increasingly depends on designing effective ways to integrate the university and the marketplace” (quoted in Slaughter and Leslie, 1997:53). This is necessary since in the global marketplace, success is not a given. However, since a degree of unpredictability is embedded in all public policy decision-making processes, “individual decision makers, and societies at large”, will constantly be required “to act on problems that are on some level unpredictable” (Guston and Sarewitz, 2002:99).

As such, arguments about academic scientific knowledge production and capitalization will continue to be debated and dissected across the academic landscape. The hope is that a strategic direction for our publicly funded universities will emerge from these intellectual debates so that all segments of the university will benefit in one way or another from the *triple helix* interactions that have emerged across the knowledge production landscape. With these divergent and contradicting findings, the study moves to consider the industrial segment of the overall project.

5.4.0 The Role of University-Based Research Cluster in Academic Capitalism

Scientific research and economic activity are linked on several levels. In terms of university—industry—government relations, the linkage is exemplified by the various attempts at the development of science parks, centres of excellence and other university-based research innovators. In relation to science parks, the ideas behind most of them are twofold: to serve as a pre-condition for economic dynamism, and also, to serve as a commitment by government to innovation. While research clusters in terms of techno-industrial complexes arise without calculated arrangements, governments and universities usually play an essential role in their development (Castells and Hall, 1994). In fact, the more a society doubts its capacity to generate

scientific excellence through the spontaneous vitality of its institutions, the more it tries to leapfrog stages of development by concentrating scientific resources in space and time, so as simultaneously to increase synergy, to gain visibility, and to generate a culture of academic excellence (Castells and Hall, 1994:40).

It should be noted that this linear model of development regeneration has been criticized on the ground that, not only is this not the only way of generating growth and

development but more so, that this approach is inaccurate description of what science parks in fact do, and therefore potentially problematic.

It is based on this line of thinking that Massey, Quintas and Wield (1992) argued that the science park model of science—industry relations leads to inegalitarian social structures, which only serve to reinforce geographically uneven development. They concluded by stating that much of the hype surrounding ‘high-tech’, whether it relates to the division of labour, social status, or geographical location, is exclusive and at the expense of those excluded. In spite of this, it remains to be seen if similar things can be said of the research cluster at the University of Saskatchewan. This study is only interested in the linkages between the park and academic capitalism. As such the analysis that follows should be viewed as complimenting the major focus of this study—academic scientists and scientific infrastructure at the University of Saskatchewan.

5.4.1 Gender and Industrial Activity

In the frequency table 17 based on representatives of private commercial companies located at the Innovation Place research cluster, female representation in this survey is once again low. The data in table 17 revealed two to one ratio of male to female industrial scientists. There were about 33% (5) females as against 67% (10) males.

Table 17: Innovation Place Respondents’ Sex/Gender

Sex	Frequency	Percentage (%)
Female	5	33.3
Male	10	66.7
Total	15	100.0

It must be stated before proceeding that it is often simplistic to assume the role of university-based industries in the production and capitalization of knowledge. While it is

true that universities are meant to provide synergy for economic development of their regions, in most cases this has not materialized beyond the conception of the idea. However, there are promising signs, as knowledge has become the prime factor in economic growth and competitiveness. As a result, industrial interests in universities have grown beyond the reliance on trained manpower to university research innovators—professors, students and academic research facilities. To some observers, this interest is taking the form of indirect expression of interest by corporate executives. As Carroll (2004) has noted, the corporate elites in Canada have expressed a growing interest in universities both as ‘incubators’ for the ‘human capital’ in which knowledge-workers invest themselves, and as catalysts for stimulating innovation and the growth of new industries.

However, as revealed by the analysis, returns on investment are not always pre-determined, and there are signs that corporate interests in universities will continue as universities are becoming competitors. This seems to be the driving force behind efforts towards closer university-industry collaboration. The data presented below represents the responses by researchers from the Innovation Place research cluster on their collaboration with the university.

5.4.2 Innovation Place-University of Saskatchewan Research Relations

This section of the analysis explores research collaboration between the companies located at the Innovation Place research cluster and academic units of the University of Saskatchewan. This is delineated using four indicators: the engagement in research collaboration, the funding of academic units, the existence of formal mechanism for research partnership, and the relationship between respondents age and their

companies support for university research. The extent of research relations between the University of Saskatchewan and the Innovation Place research cluster is examined through company's engagement in collaborative research with academic units.

Table 18: Innovation Place-University of Saskatchewan Research Collaboration

Response	Frequency	Percentage (%)
Yes	7	46.7
No	8	53.3
Total	15	100.0

As indicated in table 18, about 47% (7) of those surveyed pointed out that their companies have engaged in collaborative research with academic scientists. However, the majority of those surveyed, that is, about 53% (8) specified that their organizations have not been involved in any research collaboration with academic departments and their scientists. The results, however, indicated a significant university-industry research activity. This becomes clear when one looks at the issue of providing support (table 19). This in my view is due to the fact that there are non-profit companies located at the research cluster who act as intermediaries in seeking funding for academic units.

Table 19: Corporate Support to Academic Units at the University of Saskatchewan

Response	Frequency	Percentage (%)
Yes	14	87.5
No	2	12.5
Total	16	100.0

Table 19 considers the response to the question whether an Innovation Place company has provided any kind of support to any academic department. As detailed in table 19, about 87% (14) of the company respondents indicated a positive response. Only about 13% (2) of the companies surveyed indicated that they have not supported any

academic unit. The results show the potential there is in university-industry linkage. What are needed are formal mechanisms to regulate and stimulate this partnership. This becomes necessary when one looks at the findings reported in the table 20.

Table 20: Existence of Formal Mechanisms for Research Collaboration

Response	Frequency	Percentage (%)
Yes	4	25.0
No	12	75.0
Total	16	100.0

The data presented in table 20 represents the responses as to whether those surveyed are aware of any formal mechanisms for the conduct of research and the exchange of ideas between the companies located at the Innovation Place research cluster and the academic departments and scientists of the University of Saskatchewan. Interestingly in table 20, only about 25% (4) of the respondents think there are formal mechanisms for research collaboration and exchange of ideas between the tenants of the university-based research park and academic units of the University of Saskatchewan. The majority of the respondents, that is, about 75% (12), are of the view that there are no formal mechanisms for industry-university interaction. This is somehow contrary to studies (see Castells and Hall, 1994) that reported formal mechanisms of cooperation between university-based research parks and academic units and their professors.

In my informal discussions with these industry representatives, they stated that there are not even mechanisms for industry-to-industry cooperation. For instance, there is so much competition among the biotechnology firms within the complex that it is almost a ‘taboo’ to be seen with a researcher from another firm. Having discussed the question of formal research mechanisms it is prudent that the discussion looks at the extent to which age is a factor in terms of the support of academic research by private commercial

companies. As such, table 21 examines the association between the age of private commercial company representatives' and their company's academic research support.

Table 21: Industrial Research Support by Age of participants

Has your Company supported Academic Research?	AGE	
	20-49	50-69
Yes	92.9% 13	0.0% 0
No	7.1% 1	100.0% 1
Total	100.0% 14	100.0% 1

Chi-square: 6.904

D.F.: 1

Sig.: .008

(N=15)

The Chi-square value of 6.904 is significant at the .01 level. The results indicated an association between research work done by industrial representatives for academic units and their professors. As detailed in table 21, the overwhelming majority (93%), that is, those in the 20-49 age-groups responded in the affirmative that they have undertaken research work for academic units. Only about 7% of those within the 20-49 age-groups indicated as to not doing any research work for academic professors and their departments. This is expected since academic scientists are free to seek solutions to their research problems from anywhere. The positive side of this, however, is the fact that some academics are taking advantage of the facilities provided by the presence of the research cluster on campus. With these findings in mind, the study will now analyze the outcomes of industry-academia relations in the context of the University of Saskatchewan.

5.5.0 The Outcomes and Perceptions of Innovation Place—University of Saskatchewan Research Collaboration

As I have noted in chapter two, the processes of globalization have deeply affected higher education resulting in a ‘second academic revolution’ (Etzkowitz, 2002) or ‘academic capitalism’ (Slaughter and Leslie, 1997). These shifts are necessitated by transformations in the global economy making techno-scientific knowledge more imperative. As a result, the role of the university as a site of scientific and technological knowledge production is of crucial importance in a science-based knowledge economy. In addition, it is becoming increasingly necessary for public universities to look at non-traditional sources to fund their research in the face of diminishing government funds. As such, universities are faced with policy dilemmas in attempting to resolve current problems associated with their active participation in the global marketplace, while at the same time maintaining their role as an independent critic of society.

However, the greatest effect on academia has so far come from government and industry. This is because industrial partners are looking at ways to cut down the time it takes to conceive an idea and the time it takes to capitalize it. These demands have greatly changed the dynamics of university-industry relations. In fact, earlier configurations of university-industry relations were largely limited to consultancy services rendered to industry by the academic community. The consulting “relationships typically involved brief visits to industrial sites or conducting discrete projects on university premises” (Etzkowitz, 2002:13). In the analysis that follows, the study discusses some of the findings that relate to the outcomes of university-industry relations.

Table 22: Patent Ownership of a Corporate Sponsored Research

Response	Frequency	Percentage (%)
Yes	5	35.7
No	9	64.3
Total	14	100.0

The results in table 22 demonstrated the relationship between industry and the university in terms of patents derived from universities by industries as a result of their sponsorship of academic research. As table 22 showed, about 64% (9) of the companies surveyed pointed out that they do not hold any patent from university-sponsored research. However, about 36% (5) of the companies surveyed held a patent from university-sponsored research. This finding supports the assertion that the *triple helix* of university-industry-government relations is adequate to explain the innovation in a knowledge-based economy in that it helps in “shortening the time span between discovery and utilization” by increasing industry’s reliance on knowledge originated in academic institutions (Etzkowitz, Webster and Healey, 1998:2). It also underscores Slaughter’s (1998) view that leaders of corporations, governments, and tertiary institutions increasingly consider the universities as possible intellectual property sources.

The contradictory nature of universities participation in economic development while at the same time maintaining their traditional core academic functions have been noted in this study. The debate is not just about the viability of economic development functions but more about the influence of corporations on value-free knowledge. As shown in table 23 below, about 50% (8) of the industrial respondents indicated that industries located at the Innovation Place research cluster used university facilities to maximize profits. This supports the assertion by Kleinman and Vallas (2001) that current transformations are not limited to the domain of the university. In their view, as

corporations struggle for investment capital and for productive academic scientists, they are in turn imbibing various institutionalized practices that are associated with academia. This eventually resulted in corporations adopting and using “university-based conventions such as academically-conferred prestige to fuel their pursuit of profit” (Kleinman and Vallas, 2001: 453).

Table 23: The use of university facilities by Companies to maximize Profit

Response	Frequency	Percentage (%)
Agree	8	50.0
Neither agree nor disagree	4	25.0
Disagree	4	25.0
Total	16	100.0

In the data presented in table 23, about 25% (4) of the respondents could neither agree nor disagree with the statement as to whether the presence of the research cluster is making it possible for their companies to use university facilities to maximize their profits. The same number of respondents (25%) disagree that their companies maximize profit through the use of university facilities. It is true that private commercial companies are always concerned about profit maximization. As table 23 indicated, most industrial respondents believed their organizations are using the facilities of the university to maximize private profits. This in a way should not be surprising since university-based science parks are meant to forge links between the host university and the tenant companies in order to advance the socio-economic development of society.

5.5.1 Corporate influence on Basic and Non-Market worthy Research

Another significant issue in the academic capitalism literature has to do with the argument that as academic scientists work with industry they are under increasing

pressure to pursue application-oriented research. Paul Axelrod (2000) underscored this argument when he noted that in Canada private and public funding agencies increasingly wanted to reshape the purpose of research, to define curiosity-based scholarship right out of the equation. If the results of our labours, he noted, are not judged market-worthy, they are deemed to be of minor importance. However, as the analysis in chapter six and the responses in table 24 below show, it is difficult to generalize these kinds of arguments across the university landscape. This is because the physical, agricultural, engineering and life sciences are by their make up application-oriented disciplines. It is based on this understanding that this study calls for the understanding of the university as a ‘differentiated social system’ rather than as a ‘unified whole’ where all research and administrative policies are considered to be identical.

Table 24: Relevance of Basic Research in Industry-University Relations

Response	Frequency	Percentage (%)
Agree	2	13.3
Neither agree nor disagree	4	26.7
Disagree	9	60.0
Total	15	100.0

In table 24, about 60% (9) of the corporate respondents indicated that their collaboration with academia is not leading to the disappearance of basic research in favour of applied research. However, about 13% (2) ‘agree’ that industry collaborative research is relegating basic research to the background. In addition, about 27% (4) of the respondents could ‘neither agree nor disagree’ with the assertion that university-industry relations are relegating basic research into the background. In fact, from the perspective of industry, these findings should not be surprising as they might not want to be seen as being responsible for any real or perceived negative shifts in the behaviour of academic

scientists. However, it needs to be added that what is curiosity-driven is always a matter of agency. As I have already noted, all cutting-edge research originate from basic science.

Table 25: Relevance of Non-Market worthy Research in Industry-University Relations

Response	Frequency	Percentage (%)
Agree	1	6.3
Neither agree nor disagree	2	12.5
Disagree	13	81.3
Total	16	100.0

Linked to the above issue is the pursuit of non-market worthy research. This debate is not really different from the basic versus applied science argument but rather an extension of it. To explore this dimension, respondents were asked if they think research collaboration between university—industry—government makes non-market worthy knowledge irrelevant. Thus as indicated by the data presented in table 25, about 81% (13) of the respondents were of the opinion that their collaborative research partnership with academic units and their professors do not make non-market worthy research irrelevant. While only about 6% agreed that industry—university relations make non-market worthy research irrelevant, about 13% ‘could neither agree nor disagree’ as to whether university—industry relations are affecting the type of research academic scientists pursue.

5.5.2 The Perceptions of Industrial Impact on Research Intensity, Resource Allocation and Professorial Integrity

The perceptions among industrial representatives about the effect of commercial funding on the university are not different from the findings presented in tables 24 and 25 above. As shown in table 26, when asked about the effect of private commercial funding on the university, about 47% (7) of those surveyed indicated that the infusion of corporate

funds are actually increasing university research output. This is closely matched by the response indicating that corporate funds are enhancing teaching and learning in the university (20%). In fact, only about 13% of the respondents were of the opinion that the infusion of corporate funds are leading to the displacement of academic criteria by economic criteria.

Table 26: Effects of Corporate funding on the University

Response	Frequency	Percentage (%)
Increasing research output in the U of S	7	46.7
Displacing academic criteria with economic criteria	2	13.3
Enhancing teaching and learning	3	20.0
Other (Can't Choose)	3	20.0
Total	15	100.0

The above becomes interesting when viewed through the lens of the next table, which represents views on whether 'economic criteria are displacing academic criteria in the allocation of institutional resources'. As indicated by table 27, corporate representatives considered the allocation of institutional resources in the university to be based on economic rather than academic criteria. About 47% (7) of those surveyed held

Table 27: Influence of Economic criteria on Institutional Resource Allocation

Response	Frequency	Percentage (%)
Agree	7	46.7
Neither agree nor disagree	4	26.7
Disagree	4	26.7
Total	15	100.0

the view that economic criteria are displacing academic criteria in the allocation of institutional resources. It is, possible, that the perceptions that economic criteria are displacing academic criteria in the allocation of institutional resources are perhaps the result of the persistent call from both industry and government for universities to translate

their abundant knowledge into economic good to benefit society. Embedded, in this discourse is what is known in sociology as the ‘Thomas theorem: if people define situations as real, they are real in their consequences.

Finally, the survey explores the perceptions of industrial representatives in terms of their opinion on whether academic professors who work on private commercial company funded research threaten the integrity of the university. In table 28, about 69% (11) of industrial respondents ‘could neither agree nor disagree’ with the assertion that academic scientists who worked on corporate funded research threatened the integrity of the university. In fact, among the corporate representatives, only about 6% indicated that corporate research sponsorship undermined academic integrity.

Table 28: Effects of Corporate Research sponsorship on Professorial Integrity

Response	Frequency	Percentage (%)
Agree	1	6.3
Neither agree nor disagree	11	68.8
Disagree	4	25.0
Total	16	100.0

However, about 25% (4) of corporate representatives surveyed ‘disagree’ that academic scientists who undertook corporate funded research undermine the integrity of the university. In spite of this, the fact that about 69% (11) of the respondents could ‘neither agree nor disagree’ should be a cause for concern for all stakeholders of higher education. As Paul Axelrod (2002:41) asserted, “researchers—in the arts and sciences—who skew their scholarship to serve the interest of funding sponsors threaten the integrity of the university by surrendering their intellectual autonomy to influential patrons”. Though there is no evidence in this study to support this claim, it needs to be stated categorically that academic integrity is very important not only for the health of the

university but for the overall pursuit of knowledge. However, there is no point in exaggerating some of these perceptions. The fact of the matter is that we cannot “assume that just because researcher is paid by a particular sponsor, the researcher will abandon his or her scholarly integrity to favour the sponsor” (Renke, 2000:33).

The analysis in this chapter looked at the underlying forces at work in the transformation of academic scientific research through university-based research innovators—the perceptions of academic scientists and representatives from the university-based research parks. It is apparent from the analysis that whether academic scientist received commercial funding or not affects his perception of university-industry research relations. However, this does not mean that the growth of university-industry-government collaboration is necessarily pre-determined in favour of either private corporations or the state, nor is it necessarily at the expense the university. The analyses done in this chapter have supported the argument that in some instances, private commercial company support for academic science does not result in any market-worthy research. It has also indicated situations where there is no direct and immediate return on investment.

In addition, while there are causes for concern in terms of the decline in funding and intellectual autonomy, the overwhelming majority of professors are effectively combining teaching and research. The data analysis has also revealed that academic scientists are effectively combining basic and applied research without necessarily neglecting one over the other. The findings do not lend credence to the growing notion in some sections of the literature that university-industry relation is harming the core functions of the university. In my view, the premise of this argument is too simplistic.

The issue is more complex than usually acknowledged. However, there is the need as I have indicated to understand the university as a ‘differentiated social system’ rather than a ‘unified whole’ where all research and administrative policies are considered to be identical. By understanding the university as a differentiated social system, the various colleges and departments could be encouraged to focus on their diversity and strengths in terms of institutional resources, requirements and capabilities. With this in mind, the next chapter explores a qualitative examination of the issue of academic knowledge production and capitalization.

Chapter Six

6.1.0 The Perceptions of the Transformations of the Academic Landscape

The prospect and the actual capitalization of academic scientific knowledge have reflexively changed the dynamics of the scientific research process. It has resulted in boundary-spawning activities, some of which required the university to move beyond the publication of research and basic training of graduates to meet new demands such as serving as the vehicle for regional economic development and regeneration (Etzkowitz, 2003). In the ensuing changes, the research university has taken steps to capture the economic outcome of campus-based research by relying on what it has in abundance—human capital and knowledge. However, there is a considerable amount of concern in certain quarters that efforts directed at capturing the economic outcomes of campus-based research is negatively impacting the core functions and the public nature of the university.

This chapter is designed to explore the validity of some of the above arguments. It is also meant to find out what is happening in the transformation of the academia from the perspective of the agents who work in these structures—academic scientists. The analysis in this section is based on the findings from the qualitative in-depth interviews with academic scientists. The chapter is organized around some of the issues relating to the relevance and persistence of basic and applied science, the effect of corporate values

and practices on the academia, the role of university-based research facilities in the production and capitalization of knowledge, conflicts of interest, and the transformation of the research process mostly from discipline-based to interdisciplinary contexts.

6.1.1 The Relevance and Persistence of Basic/Curiosity-Driven Research

The blurring of boundaries between basic and applied research (Kaghan, 2001) has resulted in a paradigmatic shift in academic scientific knowledge production and capitalization. This shift is captured by the *triple helix* interface, which recognizes university-industry-government relations as key to improving the settings for innovation in a knowledge-based economy (Etzkowitz, 2003; Etzkowitz and Leydesdorff, 1997). In the in-depth interview of academic scientists, participants were asked whether private funding relegated basic or ‘curiosity-driven’ research to the background. The results were mixed. On the one hand, there are those who think that private funding is relegating basic research to the background. On the other hand, there are those who are of the opinion that this is not happening.

The study revealed that those who believed that private funding is relegating curiosity-driven research to the background tended to look at the issue based on the management of research. To them, the problem is not with the research process itself, but stems from the micro-management that privately funded research demands. The concern is that there are too many complex rules, regulations and agreements based on funds and intellectual property, gag orders for up to about two years, extra reports, timelines, and higher time investment for faculty with no changes in their teaching and administrative functions. As a result, there is the perception that by engaging in privately funded research, the time available to spend on basic research is greatly eroded. One respondent

code-named ‘Professor 1’ pointed out the possible effect of private funding on curiosity driven research as follows:

It reduces the amount of time that we have to do curiosity driven research... If our time is spent on projects related to private industry, it reduces the amount of time, and creative thinking time. We are so busy trying to manage all these projects it reduces the time for doing pure basic research. Thus, receiving so much funding from industry does become a problem. The time to reflect is luxury and that is why sabbatical leaves are so critical. It is a lot easier to bring in money through private industry. Therefore, it becomes a more attractive avenue to follow. On the output, we can still publish, get graduate students if we work with the company, so it is easier, and more lucrative, to get money and keep an active lab if we are tied to industry.

Similarly, another participant (Professor 11) notes that:

Of course there is always a lot of speculation among faculty on campus. Is that the reason or the fact that some disciplines have better access to industrial funding that? Is that the reason why they are treated better or worse than others? My basic problem is I don’t have any statistics to verify these, however, if I look at things like one of the latest additions, the idea of graduate students funding, I see that the GTF model is now going little bit in that direction. For the GTF, two-thirds are paid from the college or the university and one-third has to be paid out of grants from the individual researchers, of course as long as these individual researchers has tri-council funding, there is no big deal, but there is only so and so much money you get there and I wonder what happens if certain departments have less access to resources and then if this money goes to other units which then can use their industrial dollars to fill in that third and therefore, consequently have more students, be more productive and in the long run outperform the others.

The above statements bring to the fore the contradictions that are inherent in university-industry relations. While, acknowledging that the time required to micro-manage industry funded research may be a drain on the time available to undertake curiosity-driven research, the respondents also point out the dilemma that comes with the urge to pursue cutting edge research, which is derived from keeping an active laboratory. For instance, the respondent above (Professor 11) indicated that s/he could still publish, train graduate students and keep an active lab when engaged in industry-funded research. The problem then as I have indicated is how to manage all the requirements that come with commercial funded research. What is not clear, however, is whether by engaging in

basic research, professors' will still not have to deal with micro-managing their research activities.

Paul Axelrod (2000 and 2002) one of the most vocal proponents of liberal education has lamented a shift towards applied research at the expense of basic research. He indicates that university research that contributes to prescribe commercial purposes earns greater support and recognition than the curiosity-based inquiry that is so central to scholarly independence and the discovery of new knowledge. While Axelrod's assertion is debatable, it cannot simply be dismissed as 'ivory towerism'. Some of the academic scientists interviewed support his view. 'Professors 3, 12 and 11' concurs to an extent with his assertion by adding that industrial funded research...

probably does not support basic research very much. In my experience, industrial resource funding has got a shorter time associated with it, so they don't have the time or the interest to really do the basic research that will be involved ('Professor 3').

I would say that it could and that will partly be dependent I think upon the researcher, so certain researchers and I don't know any here but I do know some in other places who have changed their research programs to be more industrial-oriented so that they can get money that way ('Professor 12').

So of course it affects curiosity driven research because at the end of the day there are only few fields where the results do not affect the funding agency ('Professor 11').

It is necessary to consider the viewpoints of these academic scientists and critics in the debate on academic knowledge production and capitalization. If they are critically assessed and taken into account, then the debate on academic knowledge production and capitalization will mirror the ideal public sphere that Habermas has delineated. Habermas' (1991) ideal public sphere denotes a symbolic space where openness and critical-rational discourse are concurrently important. In addition, this debate will enable

a grounded assessment of the cost and benefit of university-industry relations to society as a whole. By so doing, the tension that debased the Habermasian public sphere could be avoided as the university inevitably takes on a more prominent role in the emerging science-based knowledge economy.

However, there are voices at the other end of the debate on the question of whether *triple helix* relations are relegating basic research into the background or not. There are those with the view that there is an element of basic science in any application-oriented research. To some observers this makes the demarcation of basic and applied science irrelevant. ‘Professor 4’ detailed this problematic by vigorously rejecting the basic versus applied dualism. As s/he puts it:

I object to term applied and basic research because you cannot do a quality-applied research without having a solid foundation of basic understanding of the issue. Some of the most important scholarly activities have been in the application of research and the whole government is looking at knowledge translation. How do you translate the knowledge you get in academic environments to the application of society? That’s where the public-private partnerships allow that to happen very effectively and, therefore, we all benefit from it as a society.

‘Professor 9’ concurred and added that private funding of research does not necessarily relegate basic or curiosity driven research into the background. Using a personal instance s/he indicates that:

I have received in the last few years, letters from private funding agencies that have point blank said we are looking for bright ideas no matter what they are, give us your bright idea and we will fund you.

Similarly, ‘Professor 6’ adds that in his/her opinion private funding does not relegate basic research to the background. As s/he puts it:

No it doesn’t. The Western Grains Research Foundations grant is farmer check-off money—or their endowment fund—and it really is for applied research. I told them I would like to match the grant with some federal money, which meant I had to turn change the research into very basic science for students—Masters

and PhDs. They were very okay with that. I just have to deliver the applied findings for WGRF and the more pure science findings to satisfy the federal side.

It is, however, important to state that the majority of the in-depth interview participants while acknowledging that company-sponsored research tend to be application-oriented, have also added that this is often balanced by other sources of funds that are purposely meant for curiosity-driven or basic research. As the following responses have indicated, there are checks and balances in the system to help preserve all research types. ‘Professor 1’ points out how curiosity driven research is being encouraged in the university. As s/he puts it:

The Tri-Council grants- the NSERC and SSHRC and the emphasis across campus to apply for those funds are useful in the natural sciences to encourage creative thought. I think it has really helped because it really promoted the development of more basic research on campus.

‘Professor 2’ went further by looking at the issues from the global and national perspective. As s/he notes:

I think research that is funded by private company is typically more on the applied side and I think when we look at that we have to take into account that in Canada when looking at the specific example of Canada, we don’t have the same kind of corporate industrial environment that exists in the U.S or even in the Europe where you have some very large corporations with their own very large enterprises and R&D that are to a large extent driving the research and development agenda of those countries.

When you compared Canada to any industrial country, private investment in R&D is very low. I think that’s probably one of the reasons why relatively speaking, there is probably more partnership between universities and private companies in Canada and that some of that is due to the fact that many of those Canadian companies don’t have the internal resources to do their own internal R&D on a large scale. This is because many large corporations across the world will do basic research because they know it will lead eventually to applications.

Even still, other participants went further to indicate broader contexts within which university-industry research relations are critical and why they do not necessarily relegates basic or curiosity-driven research to the background. This supports the *triple*

helix argument that whilst the discipline-based departments are converging in new ways, they are doing so by maintaining traditional lines of research (Shinn, 2002). In addition, the *triple helix* model conceptualizes the interaction in university-industry-government as key to advancing innovation settings in a science-based knowledge economy (Etzkowitz, 2003b). This assertion is underlined by the following quotes from ‘Professors 2, 7, and 6’ who have all put the importance of government funding of basic or curiosity-driven research into perspective:

I think that private companies in Canada are probably looking more at universities, first of all to have access to these basic research which is typically in the public domain, to see how it can be applied to their own problems and the challenges they are facing and in some cases they will approach a researcher, for example, who has been very successful in their area of basic research and will explore how they can collaborate to look at potential applications of that basic research (‘Professor 2’).

Curiosity research is largely funded by government and I think by the time it gets down the food chain to the point where somebody is interested in the commercial sense, then it’s only appropriate that he assessed other funds and take the benefit forward (‘Professor 7’).

In the College of Agriculture, we are applied by nature so I don’t see it as a big problem. I like the program that NSERC has, the CRD collaborative research; I think it is, whereby an industry partner can put X dollars to a project and NSERC will potentially match that funding, but with the NSERC side of the funding being geared towards the training of graduate students and Postdoctoral fellows. So by nature the NSERC half of the project becomes more basic research, whereas the industry part of the project is perhaps more applied. So you have some of both, which can be a nice complementarity (‘Professor 2’).

The above responses are contrary to what is generally acknowledged by most critics of university-industry research collaboration. For instance, Axelrod (2002) stated that research funded primarily by private industry will be designed to produce profitably sold products and will not engage the study of non-marketable ideas. As I have argued in chapter five, this is not always the case. There are instances in which industrial partners

have supported research that has not yielded any stock-market value. The findings in this research support what Blumenthal and his collaborators (1986) found in their research involving biotechnology faculty in the United States. In that research, they found that compared with colleagues doing biotechnology research, faculty receiving industry support reported significantly more publications and involvement with other professional activities but no statistically significant difference in teaching time (Blumenthal et al. 1986:1362).

It is clear from the analysis so far that there is an ongoing shift in the ideology of the university. This is nothing new or unusual since the university as a social institution has been undergoing significant transformations. It may be recalled that the incorporation of research into the agenda of the university constitutes the first major shift in its ideology. This significant but controversial change has since expanded towards the redrawing of boundaries between the production of knowledge for its own sake and market-oriented knowledge production (Etzkowitz, 2002; Kaghan, 2001). With these contradictions in mind, the next section takes up the issue of interdisciplinary research.

6.1.2 University-Industry Relations and Interdisciplinary Research

Gibbons et al. (1994) have noted that scientific, technological and industrial knowledge productions have become closely knotted, hence the interdisciplinary nature of academic scientific research. The *triple helix* model also indicated that the rigid boundaries between the trilateral nodes of knowledge production have been blurred by institutional cross-fertilization. The outcome of these changes is a collaborative production of knowledge at different intersections. However, in order to ascertain the extent to which interdisciplinary research is being conducted and the impact of private

commercial funding on this process, the study asked the in-depth interview participants whether they ‘think discipline-based research is disappearing as a result of the infusion of funds from private industry.’ The results clearly indicated that there is an upsurge in interdisciplinary research but there is not sufficient evidence to argue that the diminishing interest in discipline-based research among physical, engineering, and the life sciences has to do with private research dollars. The consensus is that there is a reduction in the extent to which discipline-based research is undertaken, as knowledge becomes the ‘axial principle’ of the post-industrial society (Bell, 1973). Consequently, the nature, and scope of knowledge has expanded beyond narrow disciplinary contours.

Accordingly, the need to analyze and comprehend the constituent elements of knowledge demands that insights and inputs from various knowledge brokers be taken on board, hence the seemingly more interdisciplinary nature of current scientific research.

As ‘Professor 1’ puts it across:

Discipline research is going down but I don’t think it’s due to increased activity with private research. It’s due to the realization that we don’t have all the expertise in one department.

Increasingly, our research is getting more and more expensive and so in order to diversify and look at the various facets within one area, we need experts who can, for example, examine the anti-oxidant values, we need experts who know how to grow the crops, and we need experts in nutrition. We need to look at all the various aspects and one department really just can’t do that.

I think in fact it’s a very positive trend because otherwise we become too narrow...we are only trained in a certain area, in order to grow and expand, I think collaborating with others outside the department and the college is essential.

Similarly, ‘Professors 2, 10 and 4’ concurs and adds that:

I will agree that probably public budgets that are available to support basic disciplinary research have probably eroded a little bit over the last few years just because of the fact that government R&D budgets have typically not grown too

much and a larger portion of those budgets are now allocated via interdisciplinary or collaborative research involving private sector ('Professor 2').

I believe that here at the U of S, we are being encouraged in fact to do more interdisciplinary and multi-disciplinary types of research activities. I don't believe that industry funding comes in with the intent to force departments to collaborate. In this department right here, this may be an anomaly in itself, but our department involves a variety of different technologies, so we will often be collaborating with people at the Institute of Agriculture Rural and Environmental Health, Animal Science, Food Science, Western College of Veterinary Medicine and other departments in this college simply based on the background of the discipline itself ('Professor 10').

I don't think that's because of private dollars. I think it just that science has become so complex and in order to solve a basic fundamental problem in a discipline, you need to learn and use other disciplines to be able to address that. So it is a fallacy if we think that we can sit in our 'ivory towers' and only look at one single discipline that doesn't cross other disciplines. Biology is a very good example where chemistry is required, mathematics and epidemiology is required, and one could say well is just biology. But it's not. You need to look at all of those aspects to be able to make again scholarly contribution to your very narrow discipline ('Professor 4').

From these we saw that interdisciplinary research is something that is being encouraged by university and college administrators. However, it is uncertain whether this has to do with the fact that it is much easier to get grants from both private and government sources, or whether it is being encouraged so as to promote the conduct of cutting edge research.

It is, however, apparent that academic scientists have recognized their individual limitations and the overall benefit of collaboration. The following excerpt from 'Professor 6' underscores this realization:

We are encouraged to do more interdisciplinary research. May be those are just buzzwords that my colleagues and other people in this college throw around...I think it's good to do interdisciplinary research because you start thinking outside your own box. If I teamed-up with someone from medicine, Medicine generally has very fine minds and lots of money and lots of momentum and Animal Science applies what's found in Medicine and Plant Science tends to then copy what Animal Science is doing. So if I teamed-up with Medicine maybe we could bring our subject to the forefront quicker.

Whilst it is clear that there is an upsurge in interdisciplinary research, it is equally important to note that there are those who look at this phenomenon with some acceptable unease. These dissenting voices are important since the formulation of any regulatory policy can only be successful if it covers all aspects of the knowledge production and capitalization.

Interestingly, ‘Professor 9’ acknowledges the possibility that private commercial funding has a role to play in the upsurge of interdisciplinary research. S/he linked this to the debate over basic and applied research and called for regulations to make sure that basic research is strengthened. In responding to the question as to whether ‘discipline-based research is disappearing as a result of the infusion of funds from private industry, s/he to an extent, agreed that this is happening by stating that:

There is a possibility. I think it can affect it definitely. I’m a bit disconcerted at the extent to which there is the push to do research that is applied in the short term, that has a short term real turn-around for commercialization for clinical outcomes, something that is going to benefit mankind immediately, but I think this is going to be a fashion that fifteen years from now will come and go just as all other fashions do. I suspect we will come to recognize ten-fifteen years down the road that we are running out of ideas that come out of curiosity driven research (Professor 9).

In spite of the above, there is enough evidence to conclude that most academic scientists are engaged in collaborative research not only with industrial partners but also with colleagues across disciplinary boundaries. Also, it is true that these interdisciplinary activities are not necessarily determined by the infusion of funds from private commercial companies. One needs, however, to understand what the effects of *triple helix* relations are on some academic values and practices. The next section explores these interacting and often debated issues.

6.1.3 Effects of University-Industry Research Relations on the Core Functions of the University

There has been a significant reconfiguration of institutional boundaries in terms of academic knowledge production and capitalization. These transformations have not only altered the research process, but have enormously increased the convergence between previously distinct organizational fields (Kleinman and Vallas, 2001). In the sphere of the university, these transformations are not unidirectional. However, in the literature on university-industry relations, the convergence of previously distinct organizational fields is often seen as less consequential. As a result, the debate by and large seems to centre on the effect of university-industry relations on the core functions of the university. For that matter, the focus of this section will be on how university-industry relations are deemed to be threatening the core functions of the university. In the in-depth structured interviews, participants expressed their opinions on whether ‘university faculty and administrators’ close working relationship with private industry is threatening the core functions of the university.’

The responses to the above question show that most academic scientists do not think that they are compromising any aspect of the university’s mission by engaging in research partnership with industry. For instance, ‘Professor 3’ clearly indicated that university-industry research collaboration is in no way affecting the core functions of the university. As s/he puts it:

I don’t believe that faculty members who are doing research with industry are compromising the education of undergraduate students or the university. In fact, it is my responsibility to ensure that all our graduate and undergraduate classes are delivered in the most effective and efficient ways possible and that there is uniform and fair distribution of workload across the faculty. So in this college, accreditation plays a major role in ensuring that we have a quality undergraduate program and so it’s really very difficult for relationships with industry cooperators to undermine the undergraduate experience.

Others went further to point out the benefits of having the university work in close collaboration with industry. ‘Professors 1, 4 and 5’, for example, have all alluded to the benefits that university-industry collaboration contributes to the performance of other core functions of the university. In responding to the question on the effects of industry-university interactions on the core functions of the university, they noted that:

It is difficult to generalize because in terms of teaching, the applied work that we do can be very beneficial because we can then provide real life examples to students about how our work can be used to benefit society, or to reflect on the areas in which industries are interested and having some research conducted (‘Professor 1’).

In fact I think it enhances the core activities of the university because they provide problems of real world situations that students can learn from...I think the major responsibility of the university is to do high quality research and training of the future generation of society and by having students’ familiar with the real world situation makes a lot of sense...We should not train people at the graduate level just to be university professors’ because about 80% of the Ph.D. graduates go to other work rather than academic pursuit (‘Professor 4’).

I would say no, I think part of being relevant at a university is working with a supporting industry in the province and the country. I think it is helpful because additional funding can allow for additional graduate training (‘Professor 5’).

These assertions are contrary to what some critics have argued in the debate on academic knowledge production and capitalization. James Turk (2000), for instance, argues that current university-industry relations have made the ‘public mission’ of universities peripheral. This line of argument in terms of the question being addressed here does not confirm what the academic practitioners at the University of Saskatchewan believed to be happening in terms of university-industry relations. As ‘Professor 7’ bluntly puts it:

I guess I would have problem with that. What is the core function of a university? If it isn’t to create knowledge for the benefit of society then I don’t know what it is for. It we just sort of seems to me that that is the mechanism by which we transform the knowledge into benefit. It seems to me that if we are not working with industry how do we do that? So it just seems to me that it’s fundamentally important for the university researchers and administrators to be working with all

parts of society but certainly with industry because they are the ones who in the end deliver the goods.

‘Professor 6’ agrees and adds that:

I am in science and even though research from my lab is not readily applicable for commercialization, I will say many of my colleagues do have things that industry will be quite interested in. I think many times industry is helped by university research but industry don’t have a role necessarily in requiring that the university always dances to their drum.

In spite of the overwhelming rejection of the assertion that university-industry research collaboration is affecting the performance of the core functions of the university, these academic scientists have also spoken of the need for caution in forging ahead with research partnerships with external agencies. As ‘Professor 6’ puts it:

I am in science and even though research from my lab is not readily applicable for commercialization, I will say many of my colleagues do have things that industry will be quite interested in. I think many times industry is helped by university research but industry don’t have a role necessarily in requiring that the university always dances to their drum.

The university should have at least the freedom for expression of ideas and industries have to bide by that.

I must be more realistic than many people because I don’t think the Coca Cola sign (exclusivity) is a big deal, but if I were told that I couldn’t carry my can of Pepsi on the U of S then I would think there is a problem. But it hasn’t got to that so I think right now it is not a big issue, it’s more of an aesthetic or idealistic theme that people push around in philosophical debates.

However, an extension of the debate has to do with the concern over the dissemination of knowledge. This issue, though overlooked by most of the participants, is critical to the health of the academia. The problem as ‘Professor 1’ has noted is based on the way university-industry research agreements are signed. As s/he notes:

I do agree that we should not do research just for private industry because they should be hiring people themselves to do a lot of work.

Why public funding should be used to benefit a company...but if we can do research or select that research carefully and ensure that all results will eventually benefit industry as a whole then I think that research is useful.

There can be a time-restriction placed on release of the information such that the company who supported the work can get a 6-12 month head start before the information is shared.

From this perspective, one cannot disregard the possibility that university-industry research collaboration is to a degree threatening the core functions of the university.

As 'Professor 8' aptly puts it:

If you have more research you have less time for teaching and administrative duties. So if I were a professor with a lot of industry sponsored research and I'm aiming for that my teaching will most likely suffer. It hasn't happened to me but if I were to have a lot of industry research, I would not likely get a teaching load reduction and my teaching will likely suffer as result.

'Professor 11' further adds that the root of the problem is not industry as such, but has to do with government funding agencies. In responding to the question on the effect of industry funding on the core functions of the university, s/he states that:

I will agree with that statement but I would like to add a little different spin to this. My problem is that when you look at Canadian funding agencies programs, there is a large amount like the CRD (collaborative research and development), that most proposal programs in the natural sciences, except for strategic grants and the discovery grants, all will require industrial collaboration or other matching money.

I try to receive money under certain NSERC programs like the CRD where money has to be chipped in from industry and the upshot of all of these is that there seems very little knowledge in industry about academic research. There is in fact a huge gap and the idea is how to bridge this gap between industry and university research and I feel that attempts that are made in Canada are totally inappropriate to ensure a close collaboration...

But with industry, they basically only ask questions like why should we participate in this, how much does it cost and if we use this manpower where does it come from? So they have mainly budgetary issues and what is completely missing in my opinion is actually a vision. The only vision industry has is to have some key functional instrument or a little black box that can be sold.

This supports the assertion that the new sources of government funding are indeed "opening the door to private direction by requiring 'partners' as a condition of researchers

getting public funding” (Turk, 2000:10). ‘Professor 12’ adds his/her voice to the debate by stating that:

The university has to maintain its level of independence so it can’t allow industry to dictate what kinds of programs are offered, what kinds of courses that are offered, and who are hired. I think those things have to be independent from any sort of industrial manipulation.

It is clear from the discussions thus far that whereas there is a cause for concern that industrial sponsored research competes with curiosity-driven research for researcher’s time, the problem cannot be attributed to just one cause—private funding of research. It is based on these findings that I argue against the growing notion that academic capitalism is harming the core functions of the university as being too simplistic. The issue, in my estimation, is more complicated than acknowledged in the literature. For an adequate and reasoned analysis, one needs to look at multiple levels of causation such as the type of research involved, the level of traditional and corporate funding, the strategic direction of the university in terms of research goals and public positioning.

Having touched on the major contours of this debate, the next section takes up another dimension of this problematic: the effect of the adoption of values and practices of corporate management by universities.

6.1.4 Effects of Industry-University Relations on the Values and Practices of the Academia

Universities have been impacting more and more on industry in other ways than the training of skilled workers. It is equally true that corporations are to a large extent imbibing various institutionalized practices that are associated with academia. The most visible of such values and practices are the use of “university-based conventions such as

academically-conferred prestige to fuel their pursuit of profit” (Kleinman and Vallas, 2001: 453). However, what has kept critics of university-industry relations wondering is the adoption of values and practices of corporate management by most public universities. Since, the debate about the Mertonian norms of science has been detailed in chapter two it will not be repeated here. As such, this section discusses the adoption of values and practices of corporate management by university administrators and their effect on the recruitment of academic faculty.

In chapter five, the effect of the adoption of values and practices of corporate management on the allocation of institutional resources was discussed using quantitative indicators. In order to analyze the impact of values and practices of corporate management on academic recruitment, the study asked academic scientists their views on the assertion that ‘economic criteria are displacing academic criteria in the recruitment of academic faculty as the university administrators and academic faculty adopts values and practices of corporate management.’ The responses to this question were mixed and diverse. It seems, however, that in most instances, economic criteria in the form of a faculty’s ability to pull in grants is part and parcel of the academic criteria.

As a result, economic criteria cannot be attributed to being the outcome of the rationalization of the academia through the adoption of corporate values and practices. The following quotes from some of the participants attest to the divergence and the embeddedness of the way corporate values and practices are seen to be at work in the transformation of the university. For ‘Professors 1, 8, 11 and 2’,

I can only tell you from what my experience is from our college. Our college/department tend to hire not based on areas that will bring the most money but the areas or holes that we need to fill, from a teaching perspective and then the research follows after that...so we first look at the curriculum. What are the qualifications of a person who needs to fill the holes in our curriculum? And then

how good is their research? Anyone who is an excellent researcher, no matter what his or her area, should be able to bring in money... However, I should add that the curriculum to a certain extent does reflect the changing career opportunities and so from those perspectives, economic criteria are indirectly influencing hiring ('Professor 1').

There is that feeling on the campus. Also it is a general trend in the universities in Canada that they recruit people who are more able to bring in more research dollars. I think that should not be the case, and that it should be the recruitment of people who are able to balance research, administrative and teaching responsibilities and be able to do research very well ('Professor 8').

In terms of recruitment, the trickery thing is that it is a little bit of chicken and the egg problem. One would rarely hire a faculty member from my eyes who does something where we expect that they will have problems publishing their results. Where is publishing their results interesting? Because if you publish the results and perform well, Tri-council will reward you with grants, so there is always a little bit of money issue down the road because if someone has grants he can fund his research and he doesn't live off the back of others ('Professor 11').

In terms of recruitment, personally, I have not seen that in a college such as ours, which is a professional college. What are we looking for in terms of delivering programs that are accredited at the national level? We need to hire people who have professional qualifications to teach students in those programs so the professional components of the qualifications has not changed, it always remain that. We need to hire people who will be able to provide sound engineering education to our students...What we are may be doing more now than we did in the past is that we are probably focusing more on the academic qualifications of a faculty member in terms of their potential to conduct more leading edge research and scholarly activity ('Professor 2').

In addition, there are those who acknowledge the increasing role of economic criterion in the general administration of the university but reject the assertion that economic criteria hold sway over academic criteria when it comes to the issue of recruitment. These groups of participants tend to see economics in the larger picture of regional economic development rather than merely as an academic transformation brought on by corporate influence. 'Professor 2' underscores this perspective when s/he states:

I think economic criteria are probably more important now in terms of the overall management and administration of university than they were in the past. I think one reason is that universities now need to be more accountable to society because society through government and through individuals whether they are students or students' parents, were basically providing financial resources to the university. I strongly believe that universities need to be more accountable because we have a responsibility to manage all those resources that are allocated to us in a responsible fashion.

In fact, I don't see any problem in universities being managed more in a way that is closer to what you find not only in the private sector but in any like organization whether it is government department or a private corporation. I mean you won't see a whole lot of difference in terms of the way those large organizations are managed and operated. So I think it's beneficial to university that we first of all acknowledge the fact that we need to be responsible and accountable because those are not our resources but resources provided to us by society and we need to be basically only the stewards of those resources.

I think may be in the past, universities were perceived to be like 'ivory towers' that were not accountable to anybody, just provide them with resources and they will do the best with those resources because they are academics, and they know best, I think this perception is no longer true, and we are part of society and we need to operate and function just like the rest of society.

It is clear that both the proponents of the *triple helix* relations and its critics have a point when it comes to the influence of industry on university and vice versa. However, one cannot make a definitive connection between the adoption of values and practices of corporate management with the decline in productivity of academic faculty and the overall performance of the mandate of the university. In spite of this, it seems that there is an association between economic criteria and academic criteria in that those who have a very good academic qualification and active research agenda have the highest potential to bring in research funds from any funding agency, either public or private or both.

The analysis thus far has supported the *triple helix*'s assertion that university-industry-government relations create a new overlay of trilateral linkages, which stimulates organizational creativity. This organizational creativity, in turn results in a recursive effect not only on the inter-institutional networks representing academia-

industry-government, but more so, on their originating spheres as well as the larger society (Etzkowitz et al. 2000). As such, it is possible that as the university adopts values and practices of corporate management, it does not necessarily displace traditional university values and practices.

6.1.5 University-Industry Research Relations and Conflicts of Interest

In spite of several instances of contradictions in academic knowledge production and capitalization, critics of academic-industry relations have argued that the university risks losing its identity as an independent critic of society, and its special purpose by engaging in the capitalization of knowledge (Etzkowitz, 2002). A recurrent supposition in the literature is that there is a conflict between university values and economic values. This stems from the underlying perspective that sought to characterize the publication of research and production of graduates as the most appropriate role for an institution dedicated to the public good. Therefore, by engaging in knowledge capitalization, academic scientists are involved in activities that border on conflicts of interest and conflicting interests to some observers. Society not only views conflicts of interest negatively, but also as a potential malfeasance and as such dysfunctional (Etzkowitz, 2002). In this study, participants were asked if they think there is a ‘conflict of interest between the public nature of the university and research partnership with private industry.’ In addition, they were asked to indicate how the university should resolve such problems.

As is always the case in issues that border on opinion management, there are those who acknowledge that there are conflicts of interest and propose ways of dealing with

them. For instance, ‘Professors 6 and 10’ put the issue of conflicts of interest in the following ways:

Yes, many times there is a conflict. Many research programs are funded from combined sources of funding through leveraged or matched partnerships. I remember going for a grant with a company in Innovation Place and they were probably looking for something more applied than I wanted. So many times industry, particularly if a company doesn’t have a trust fund and is not doing very well financially, is looking for quick fixes, which is not the same agenda as a researcher. If you get involved with a company like that, you still need to publish....I have to publish otherwise I will lose my job. I would not make the cut. My students need to publish too if they want to enter academia... publish or perish, and you can’t afford to get into situations where you have to sit on the data for a couple of years to give your industry partner a chance to commercialize the findings (‘Professor 6’).

That can depend very much on each case. The way I envision this scenario, there are conflicts of interest. On a small scale, in each collaboration, one should try to avoid conflicts through thorough memos of understanding so if from the beginning all possible scenarios are laid out one can try to reduce conflicts. On a larger scale as well as on the small scale there is the danger of the private partners trying to steer research and its directions where they should not...There is of course a huge conflict of interest because I would not think that they [companies] have the vision or the capability of telling the university researchers which directions the research should go. Again I see conflict of interest and I am not a big fan of this attempt to try to unify research and university because the bottom line of this is that research looks at details and wants to get more knowledge about certain things. This is in complete contrast to the current trends in society where the focus is never on details (‘Professor 10’).

On the other hand, there are those who argued that the issue of conflicts of interest depends on a case-by-case basis and that there is no way the problem can be generalized across the entire scope of university-industry relations. This perspective is highlighted by the following contribution from ‘Professor 1’ who indicated that the issue of conflicts of interest varies from one research project to another. As s/he puts it:

It depends upon the research project but if you want me to generalize overall, I’ll say yes, I think there is more potential for conflict of interest. But I think it depends on the field--you are talking about medicine versus agriculture, or veterinary medicine versus engineering. It’s hard to generalize across those fields, but in general there is more potential for conflict of interests.

‘Professor 2’ argues further that there is no conflict of interest as long as collaborative boundaries are set from the outset of the research project.

I think there is no conflict of interest as long as both sides fully understand what expectations they can have from other side. So I think for as long as private companies understand accept that universities are public organizations, that their funding is coming from public sources and also through private citizens through tuition fees, and that the mission of universities are to educate people and to contribute to the advancement of knowledge, I don’t see any problem.

I think in most collaborative research that I have been involved with involving industry, it’s very clear to those private sponsors that as part of the research that I am doing within the scope of my duties at the university, there are expectations that I may have to train graduate or undergraduate students in some projects and that will take time, and also we expect that some public dissemination of the research results will occur.

I think on our end, we need to understand the time and money constraints under which the private companies operate. It is our responsibility not to create unrealistic expectations. I don’t think we can lead private organization to believe that collaborative research they will be doing with university will be the same as if they are dealing with a scientific consultant for example, because we don’t have the same responsibilities and accountabilities that a consultant has.

‘Professor 3’ broadens the scope of the debate by linking the issue to the availability of funds and the need to run the university smoothly, which requires adequate funding. As s/he notes:

I don’t have the details specifically, but my believe is that the public funding for this university does not pay for all of the U of S bills, so based on that I don’t believe that the residents of Saskatchewan have paid for all of the researchers’ time. Therefore, if we are going to balance the book, so to speak, on campus, we need to find those resources somewhere else. Where do we get them? Well we get some from tuition, in which case we certainly do have a commitment to students to deliver quality undergraduate and graduate programs but also we have funds that come in through research contracts, where we are doing confidential research with industrial partners. So unless the public is prepared to pay for all of the expenses that go on in the university, I don’t think there is a conflict of interest there.

It is true that the critical analysis of any role will definitely indicate some sort of underlying conflicts of interest, which are usually embedded in the role no matter how luminously the functions are discerned. This is definitely true of academic norms and

industrial behaviour. The way forward always tends to be how to detect and ultimately deal with the problem in this case, confining a conflict of interest within acceptable ethical boundaries. In the case of academia-industry relations, “there are instances of conflict of interest and cases of conflicting interests. The ethical requirement is not to prohibit conflicts of interest but to regulate and adjudicate conflicting legitimate interests” (Etzkowitz, 2003:116). In this regard, conflicts of interest may “signal transition to a new academic model” by exposing “assumptions about the purpose of higher learning and the legitimacy of an economic role for the university” (Etzkowitz, 2002:14-15). However, my take on the problem is that there are conflicts of interest in *triple helix* relations that need to be negotiated and resolved so that they do not threaten the integrity of the academy and the knowledge production process as a whole.

Consequently, policy guidelines are needed to regulate and ultimately make it easier for academic scientists to collaborate with industrial partners. This is in the greater interest of the university and its faculty, if we are to avoid future Nancy Olivieri shambles. To put this widely publicized case into context, Nancy Olivieri was a researcher and professor at the University of Toronto. She was working on a university-industry funded research dealing with an experimental drug *deferiprone*, which is used in the treatment of the blood disorder *thalassemia*. Olivieri was enthusiastic about the drug’s potential and signed a ‘confidentiality clause’ with the industrial partner *Apotex*. This agreement stipulated that she would not publish the findings of her research without the company’s authorization. However, when she realized that there might be long-term effect on patients, she wanted to publish her results in spite of the agreement that she had signed. The company prevented her by threatening a legal action. She subsequently lost her

position as the head of the haemoglobinopathy programme at the Hospital for Sick Children in Toronto, thus preventing her from continuing her clinical trials (Axelrod, 2002:105). Though she was later reinstated following a public campaign, this has become a test case for university-industry relations in Canada, and more so, for critics who refer to this as the *raison d'être* to reject all forms of university-industry research partnerships.

Therefore, to avoid the repetition of such instances, agreed upon principles are very necessary. 'Professor 6' puts this into perspective with an example from the College of Agriculture: As s/he notes:

In my department my colleagues develop crop cultivars or varieties. The department owns the intellectual property their distribution rights are owned by the industry group. It just depends on who is willing to go to court and how valuable something is. We don't like court, and we like our findings to be made public.

The fact that private commercial companies have the financial backbone to afford numerous rounds of litigation from the onset puts universities at a disadvantage. The remedy to forestall the occurrence of undesirable developments is an independent review of all contracts taking into account the concerns of all the stakeholders. Almost all the participants agreed that there is the need to deal with potential conflicts of interest even before they actually occur, and many have put across certain suggestions as to how we should proceed. This is a positive step in that the solution is coming from practitioners who understand the nature and intricacies involved in their vocation.

The overwhelming suggestion for dealing with the issue of conflicts of interest is total openness and complete disclosure of any university-industry research collaboration. 'Professors 3, 5 and 8', reflects upon these ideals in the following quotes:

I think it has to start with complete and total disclosures, make sure everybody is aware of what is happening and that we need to have people who recognized the conflicts of interest or even perceived conflict of interest to bring those to the attention of their supervisors and say this is what I'm intending to do. There may be a perceived conflict of interest and I need you to judge and if it is something that can't happen then I can't do it, but if it is something that can happen then I need to be notified that this is allowed ('Professor 3')

Ideally, prior to the research beginning in terms of allowing the university researcher the ability as much as possible to publish their results, to speak about their results freely in scientific meetings and at other public forums, realizing that if you are working with a private company, they may want to keep some level of confidentiality, but as much as possible the researchers should be given the freedom to discuss and control their results in terms of publication and the media release of their results ('Professor 5')

I think one way to minimize it is for the university to institute a review process, if they are aware that a research project initiated by a researcher for an industrial support, then it should be reviewed as to how the knowledge will be generated transferred, and license. That way, we are assured that we are addressing the issue very well. I think just like they do now for ethics review, I think this should also be applicable to industrial supported research should also be reviewed as to whether there are conflicts of interest, common goods versus private goods ('Professor 8')

The issue of conflicts of interest and conflicting interests are not figments of one's imaginations. They are real and addressing them head-on will contribute greatly to the health of the university. The few suggested solutions above are necessary and point toward important first steps that must be taken seriously. Such considerations must be at the heart of any policy guideline that may be put in place to regulate university, industry and government research partnerships.

6.1.6 The Impact of University-Based Research Innovators on the Capitalization of Knowledge

It has been noted that the capitalization of scientific knowledge, particularly its conception as intellectual property is motivated by factors, such as the rise of technologies based on generic forms of knowledge, the erosion of universities' grant

economy, and the university's ability to hold and exploit patents (Baber, 2001; Etzkowitz, Webster and Healey, 1998). These advances have reflexively changed scientific research to take on new dimensions, which revolve around boundary spawning activities. Consequently, most universities have taken steps to capture the economic outcome of campus-based research by relying on what they have most—human capital and knowledge. For that matter, a central objective of this study is to understand the perceptions of academic scientists of the production and capitalization of knowledge. In the in-depth interview, participants were asked whether they think the presence of university-based research innovators such as the Innovation Place or the synchrotron leads to the commercialization of academic research.

While the above question is only looking at one dimension of what has been conceptualized broadly as research innovators, the findings are quite revealing. Most participants were of the view that the presence of these university-based research innovators provides the synergy and the motivation needed to move research to the next logical step in this case capitalization. In the words of 'Professor 3', the implications for academic research could not have been clearer. The university-based science park and the synchrotron were not located on campus to perpetuate the 'ivory tower' function of the university. They are meant in his/her estimation to enhance the production and capitalization of academic research. As s/he notes:

Absolutely...the opportunity to gradually grow out of the university-based labs into the 'Innovation Place' is the next logical step to get academic research commercialized (Professor 3).

‘Professor 7’ agrees and adds:

Yeah, I think it helps...If you look around the world, places where they had, for example the Silicon Valley, most of the Silicon Valley are direct spin-off of Stanford research, Stanford University and so I think if we are going to set out to have some economic development, one of the things I think we should do is built Innovation Place type research park and try to get them working closely with the university.

While the above examples indicate the possibility that university-based research innovators are leading to the commercialization of academic research, ‘Professor 5’ moves a step further to indicate that commercialization of academic research is indeed happening. Using a personal example, s/he states:

I think so. I think that’s their purpose and I think that is happening. I can’t speak very thoroughly on that topic but I can speak to one example in the sense that the group I’m involved in is involved with a group...based at Innovation Place and we work with them very closely and they are involved in the commercialization of academic research to a large extent. That’s not the only thing they do, but it’s one of the things they do. So yes, I think that partnership between university-based researchers and organizations at Innovation Place can certainly lead to the commercialization of university research.

There is no lingering doubt that the academic scientists involved in this study believed that university-based research innovators played a significant role in the production and capitalization of knowledge. However, what is not clear is the way knowledge is translated into an economic activity. For ‘Professor 1’, the process is indirect, but very essential.

I don’t think that there is a direct relationship between having a research park and more collaboration. But it makes it easier for both- for industry to try to seek us out and create more wings...so it facilitates it, it is not absolutely required but it does enhance it...I think it makes it easier. I think really whether we have a synchrotron on campus or ‘Innovation Place’, is similar to collaboration...it reduces the barriers that they have to go through to gain some collaboration with industry, thus it does makes it easier...it is critical if you want to achieve the highest level of possible activity. So, for example, if I’m interested in synchrotron research rather than go to the US, Europe or Australia, I can do it right here and because of the incentives that come with using facilities like that then it makes it even more attractive.

‘Professor 9’ rejects any direct relationship. As s/he puts it:

I don’t think it directly lead to the commercialization of academic research. I think it may tweak people to think more in terms of what the potential is for their research to be commercialized. It may be conducive to some extent to that, but I don’t think it’s a direct relationship.

That these university-based research innovators have the potential to create and ultimately provide the opportunity and mechanism for the translation of scientific research into economic activity is without doubt. The response by ‘Professor 1’ underscores the inextricable link between scientific research and economic activity. As s/he puts it:

There will still be certain percentage of the scientific population who will forge those collaborations no matter where they or industry are located. But if you want to have the maximum amount of collaboration then it is essential that those facilities to be located close to the university.

In spite of the evident benefits to be derived from the utilization of university-based research innovators, the entrepreneurial nature of most universities seems to the critics of capitalization of academic scientific knowledge to be the last straw that has taken the university irreparably away from the idealized ‘ivory tower’. It has been argued, for instance, that the basic function of universities is under threat as a result of the growing commercialization of universities (Turk, 2000). The meaning of this claim becomes clear only when analyzed within the context of Humboldt’s utopian ideals of a university. This idealized university inducted the liberal, humanistic university of the nineteenth century. In this period of liberal modernity, the Enlightenment project brought about the rationalization of culture in the name of universalistic science (Delanty, 2002:32).

Thus it is apparent that recent developments in knowledge production such as the changing role of the state from government to governance, the emergence of new knowledge producers, and the emergence of new links between society and knowledge have significantly call into question the 'Humboldtian' ideals of the university (Delanty, 2001). In spite of this, it is true that some sections of the university are at a greater risk of being marginalized from university-industry-government relations based on knowledge capitalization. Axelrod (2002) stresses that research funded primarily by private industry will be designed to produce profitably sold products, and will no longer engage the study of non-marketable ideas. This in his estimation will result in marginalization of the Humanities, Social Sciences, and Fine Arts in most public universities.

However, if one takes Hohendahl's (2005) critical but incisive account on the future of the research university and the fate of the Humanities as a yardstick, then the picture is not all that gloomy, particularly for the Humanities. For Hohendahl (2005), reliance on private funding, either in the form of gifts or in the form of entrepreneurial research, will reinforce the trends of the past decade. As he noted, the development of English departments in the United States was characterized by the early split between research-oriented professionals, who believed in the rule of philology, and the generalists, who cared about teaching values to undergraduates. For him, the faculty in the Humanities has not yet fully grasped the nature of the structural transformation underway in modern universities. This accordingly explains why the Humanities have responded more to specific phenomena such as the job market rather than the altered structure itself (Hohendahl, 2005: 13-14).

The fact of the matter is that the research university will be faced with serious funding problems and these funding shortfalls will shape crucial policy decisions. In these decisions the concerns of the natural sciences and technical programs will be pivotal because their continued existence depends on the ability of the university administration to raise necessary funds. By contrast, the cost of maintaining the humanities has not been a crucial problem and thus has not been treated as a high priority issue. For this reason, it is conceivable to admit that the Humanities and some units of the Social Sciences may not produce commercializable knowledge (Hohendahl, 2005).

However, as financial constraints hit universities, there is the need for some academic departments and colleges to put in place strategic measures that will enable them to focus on their strengths while collaborating with other departments to see how they can pull resources together to deliver courses that are similar in content and identical in terms of objectives. Moreover, in the allocation of resources, the university has to spread the benefits of university-industry research partnership beyond the immediate departments and colleges that makes it possible. This thus calls for the understanding of the university as a ‘differentiated social system’ rather than a ‘unified whole’. By so doing, policies put in place will not be simply cosmetic, but will drastically enhance the health of the university.

Chapter Seven

7.1.0 Summary and Conclusions

In this study, the transformation of academic scientific research is mapped-out using academic scientists in the agriculture, bio-medical, computer, engineering and the physical sciences as the unit of analysis. The debate is organized around the effects of the alteration of institutional regimes of knowledge production on the traditional mission of universities through the prism of the *triple helix* of university-industry-government relations. The *triple helix* interface reflects the outcome of the interaction between practical and institutional dynamics in society. It identifies the relations between university-industry-government as key to improving the sites of innovation in a science-based knowledge economy. The *triple helix* model accounts for the multiple but mutual interactions among the institutional regimes of knowledge production at different points in the knowledge capitalization process. The study notes that although, it is possible for one to pragmatically select specific indicators based on the availability of a rich data-set, one has to always rationalize why such a specific measurement would be valuable for the assessment being undertaken. As such the study relied heavily on survey research as a methodological tool to collect and analyse data.

The primary argument of the study is that the growth of university-industry-government collaboration is not necessarily pre-determined in favour of either private

corporations or the state, nor is it necessarily at the expense of universities. Consequently, the growing notion that academic capitalism is harming the core functions of the university is overly simplistic as the issue is more complicated than usually acknowledged. It was further argued that because of the complexity of the modern university, there is the need for one to understand the university as a ‘differentiated social system’ rather than a ‘unified whole’ where all research and administrative policies are considered to be identical. What has been delineated as a ‘differentiated social system’ is built on Luhmann’s (1982 and 1996) characterization of internal differentiation. For him, forms of differentiation determine the degree of complexity that a society can attain.

Thus in the context of university-industry-government relations, differentiation will enable the university to pursue all its functions without any particular one dominating other activities. In other words, there will be a deep-seated and recurrently growing functional specialization such as the adoption of economic development agenda in addition to teaching, research and community engagement. This understanding will supersede the way we currently view the university as a ‘unified social system’, which in principle denotes the subordination of all activities under a homogenous umbrella of one size fits all. By understanding the university as a ‘differentiated social system’, the various colleges and departments could be encouraged to focus on their diversity in terms of institutional resources, requirements and capabilities.

In surveying the transformations in the realm of scientific knowledge production and capitalization, the study traced the development of the sociology of knowledge. As a sub-discipline, the sociology of knowledge has a blend of epistemology and sociology traceable from Hegel to Marx. In spite of this insight, for a very long time, sociological

interest in knowledge has continually focused on the shifting and comparative character of knowledges. Thus the sociology of knowledge, notwithstanding its broad usage, has been principally concerned with how social groups and forms of social organization have contributed to the production and dissemination of knowledges. In this study, classical sociological conceptualizations of knowledge were used to anchor the debate within contemporary social thought. In fact, it has been noted repeatedly that knowledge production and utilization has undergone many transformations and that these changes are affecting the university as a unique institution and as the citadel of knowledge.

The role of the university of course goes beyond the narrow sphere of knowledge production. However, as knowledge becomes one of the key factors of development and international competitiveness in a globalized world, universities have broadly been recognised as agents of socio-economic development and regeneration. This shift has correspondingly resulted in the emergence of multiple knowledge producers. As a result, some observers have noted that knowledge production has shifted to a degree from the university as a sole producer to a range of non-university settings, such as industrial laboratories, research centres, think tanks and consultancies (Gibbons, et al. 1994).

Additionally, the emergence of new links between society and knowledge is another recent development that has affected the landscape of knowledge production. As new innovations create both scientific and social uncertainty, knowledge is rapidly becoming a new site of conflict in society. However, there is no denying the fact that scientific research and economic activity are interlinked on numerous levels. In terms of university-industry-state relations, the linkage is exemplified by the various attempts at the development of science parks, centres of excellence and other university-based

research innovators. Based on this science-society interaction, sociologists from diverse perspectives have devoted quite a significant amount of time and effort to surveying the relationship between knowledge and industrial structure. The way and manner knowledge is produced and used differ but one phenomenon that seems to be global in its orientation is the planned development of science and technology parks.

In the sociological literature on academic scientific knowledge production and capitalization, two models readily stand out as explanatory tools. The first of these works, the *New Production of Knowledge* (Gibbons et al. 1994), sought to theoretically explain the current changes in the field of scientific research. In the second work, Etzkowitz and Leydesdorff (1997) used the metaphor of a *Triple Helix of University-Industry-Government Relations* to analyze the institutional transformations occurring and the policies encouraging the university to participate as dynamic entrepreneurs. The *triple helix* model in addition to framing the knowledge infrastructure notes that an overlay of communications and negotiations among the three institutional partners has increasingly become important for the dynamics of the overall system (Leydesdorff and Etzkowitz, 2003c). Accordingly, in the production, exchange and use of knowledge, the *triple helix* has noted the blurring of the rigid boundaries between basic and applied research and an increased institutional cross-fertilization.

However, it should be noted that while the discipline-based departments are converging in new ways by maintaining traditional lines of research, the *triple helix* model recognizes that at the same time, they are also turning to industrial research and other intermediary forms of research. As have been detailed, the evolution of university-industry-government relations in the Canadian context has already been through at least

three phases, one of which corresponds to the global institutionalization of science. This leads us to survey the effect of Canada's national system of innovation on academic science. It was noted that the dawn of the modern version of university-industry-government research relations was enhanced in the 1980s, when research-granting councils such as SSHRC and NSERC created matching policies to promote collaboration between industry and universities. The outcome of these policies was an upsurge in industry-university collaboration.

However, the focus of the study was the perceptions of academic scientists of the production and capitalization of knowledge. Utilizing survey methodology, the study explores changes within the landscape of knowledge production. It notes that early attempts at knowledge production mimic the linear Newtonian model where the site of knowledge production was entirely separated from that of application (Gibbons et al. 1994). A central issue in the debate about the consequences of university-industry-government relations is the issue of private industry funding of university research. In order to ascertain the veracity of claims about the privatization of the university, the study examines the extent of academic faculty's reliance on private sources of funding. From the analysis, when one controls for rank, about 59% of full professors and 50% of associate professors indicate receiving funds from private commercial sources. Only 8% of the recipients of private commercial funding were assistant professors. The result also shows that about 24% of full professors and about 8% of assistant professors have a spin-off company based on their research. These results did indicate that whether a professor receives commercial funding or not has a significant impact on his/her perception of university-industry research collaboration.

The debate over the transformation of academia is at the heart of this study. Although, all types of knowledge are interest-laden, the idea of the neutrality of knowledge has been at the centre of the debate about university-industry-government relations. The perception is that academic scientists who engage in collaborative research with industry are inherently skewing research and scholarship in favour of their industrial patrons, jeopardizes academic freedom and above all infringes upon scientific neutrality. It has been argued with the support of both the quantitative and qualitative data that the interpretation that corporate funding of academic research is setting academic research agenda is perhaps too simplistic. As the analysis have shown in some instances, academic scientists who received commercial funding are likely to have a positive perception of the influence of corporate power and loss of intellectual autonomy. On the other hand, there are instances that even non-commercial funding recipients are more likely than commercial funding recipients to perceived corporations as having the right amount of influence. As such, the issues of academic capitalism are very complex and variegated that one has to be cautious when talking about the influence of private commercial companies on the university.

This study seeks as one of its objectives to find out whether the *triple helix* of university-industry-government relations relegates basic or curiosity-driven research to the background. It was realized that about 53% of academic scientists do not think that university-industry relations relegate curiosity-driven research to the background. It needs to be stressed that there is still the possibility that, in reality, basic science is being relegated into the background. In addition, the study establishes that, in general, academic scientists tend to see economics in the larger picture of regional economic development

rather than merely as an academic transformation brought about by corporate influence. It seems that there is an association between economic criteria and academic criteria in that those who have very high academic qualification and active research agendas have the most potential to bring in funds from all sources.

Consequently, most academic faculty respondents do not view the increasing use of university facilities by industry as leading to the privatization of the university. Whilst only about 8% of academic scientists who have received commercial funding agree that the increasing use of university facilities by private commercial companies is leading to the privatization of the university, about 34% of non-commercial funding recipients believed the industrial use of university facilities are leading to the privatization of the university. However, about 62% of commercial funding recipients and about 53% of non-commercial funding recipients all disagree that the university is being privatized through industrial use of its facilities. Based on these figures, it is plausible to state that the sourcing of private funds for academic research does not necessarily lead to knowledge being a private good.

Apart from the privatization of knowledge, intellectual autonomy is another very important issue in the debate about the production and capitalization of academic scientific knowledge. About 12% of academic scientists who received commercial funding and about 24% of those who did not received commercial funding indicated that university-industry relations are leading to the loss of intellectual autonomy. However, the majority that is about 65% of those who received commercial funding and about 33% of non-commercial funding recipients all disagree that university-industry relations are leading to the loss of intellectual autonomy. The results showed that about 31% of

assistant professors and about 28% of associate professors are of the opinion that university scientists who conduct private commercial company sponsored research are surrendering their intellectual autonomy to these influential patrons. It is quite remarkable that the number of assistant professors who agree that university scientists who conduct private commercial company sponsored research are surrendering their intellectual autonomy to these patrons exactly equaled those who disagree. There is also a generational gap in that the understanding of the effect of university-industry collaborative research seems to vary according to the rank of the professor.

Consequently, the problem that must be underscored in any debate on the role of the university in the science-based knowledge economy has to do with tacit knowledge. Do we have to pursue capitalizable knowledge at the expense of other knowledges? It is clear that arguments about academic scientific knowledge production and capitalization will continue to be debated and dissected across the academic landscape. The hope is that a strategic direction for our publicly funded universities will emerge from these intellectual debates so that all segments of the university will benefit in one way or another from the *triple helix* interactions that have emerged across the knowledge production landscape.

It is often very easy and simplistic to assume the role of university-based industries in the production and capitalization of knowledge. Industrial interest in universities has grown beyond the reliance on trained manpower to university research innovators—professors, students and academic research facilities. In spite of this, the study reveals that there are no formal mechanisms for the conduct of research and the exchange of ideas between Innovation Place companies and the academic units at the

University of Saskatchewan. In terms of the relationship between industry and the university regarding patents, about 36% of Innovation Place companies hold a patent from university-sponsored research.

Furthermore, the contradictory nature of universities participation in economic development while maintaining their traditional academic functions has been noted in this study. The corporate respondents indicated that their collaboration with academia is not leading to the disappearance of basic research in favour of applied research. Only about 13% of the respondents agreed that industry collaborative research with academia is relegating basic research to the background. Corporate representatives believe that the allocation of institutional resources in the university is based on economic rather than academic criteria. From the data analysis, about 47% of those surveyed were of the view that economic criteria were displacing academic criteria in the allocation of institutional resources at the University of Saskatchewan.

In addition, the perception of industrial representatives in terms of their opinion as to whether academic professors who work on private commercial company funded research are threatening the integrity of the university was explored. From the study, only about 6% of those surveyed agree that academic scientists who performed corporate funded research are undermining the integrity of the university. In fact, based on these findings, it is possible to assert that the future viability of policies encouraging universities to be entrepreneurial may, if approached strategically, be a catalyst for the science-based knowledge economy. This is because the prospect of and the actual capitalization of academic scientific knowledge have reflexively changed the scientific research process. In the ensuing period of change, the research university must take steps

to capture the economic outcome of campus-based research by relying on its most basic endowment—human capital and knowledge.

Moreover, the study also revealed that those who think private funding is relegating curiosity-driven research to the background tend to look at the issue based on the management of research. To them, the problem is not the research method, but is derived from the micro-management that privately funded research entails. While, acknowledging that the time required to micro-manage industry funded research is a drain on the time available to undertake curiosity-driven research, respondents also point out the dilemma that comes with the urge to pursue cutting edge research that requires an up to date laboratory. The problem as the study reveals borders on how to manage all the requirements that come with industry-funded research. What is, however, not clear is whether by engaging in basic research; professors will not have to deal with micro-management of their research and student mentoring activities.

Gibbons et al. (1994) have noted that scientific, technological and industrial knowledge productions have become closely intertwined, hence the interdisciplinary nature of academic scientific research. The *triple helix* of university-industry-government relations has also pointed out how the rigid boundaries between the institutional nodes of knowledge production have been blurred by institutional cross-fertilization resulting in knowledge being collaboratively produced at different intersections. There is not sufficient evidence in this research to argue that the lack of enthusiasm towards discipline-based research in the physical, engineering, and life sciences has to do with private research dollars.

In spite of the overwhelming rejection of the assertion that university-industry research collaboration is affecting the performance of the core functions of the university, the academic scientists involved in this study have also spoken of the need for caution in forging ahead with research partnerships with external agencies. It is apparent that critics and proponents of the *triple helix* relations all have a point when it comes to the influence of industry on university and vice versa. In terms of conflicts of interest, the overwhelming suggestion for dealing with these issues whether real or perceived is total openness and complete disclosure of any university-industry research deal.

There are no lingering doubts that the academic scientists involved in this study believed that university-based research innovators played a significant role in the production and capitalization of knowledge. In spite of this, it is true that some sections of the university are at a greater risk of being marginalized from university-industry-government relations based on the type of knowledge they produce. This study has touched on several dimensions of academic knowledge production and capitalization. It is prudent to conclude by restating its core tenets. In an increasingly science-based knowledge economy with the desire to identify and add new innovative methods to economic development, universities have become contested terrains. This is due to the realization that universities are perhaps the uncharted zones of knowledge required to fuel today's science-based knowledge economy.

Consequently, the desire to translate academic science into economic activity has collided with the rise of an increasing nostalgia for the romanticized 'ivory tower'. Therefore, the close collaboration between the three institutions of knowledge production—university-industry and government has generated so much debates and

tensions. The fact of the matter, however, is that changes are happening around various university campuses. Thus, instead of exchanging tirades about university-industry relations we should rather channel our efforts at ways to manage these significant developments so as to broaden the benefits and minimize the risks and costs to universities.

It is hoped that this study has met its objectives and as such the following conclusions can be drawn from this research:

1. That university-industry research collaboration enables the perils of the market to dictate the type of research to a degree but nonetheless creates economically valuable output.
2. That *triple helix* relations enable research to go beyond narrow disciplinary boundaries, which ultimately keeps researchers grounded in reality,
3. That there is the need for policies such as total disclosure of research involving university and industry, who is engaged in what type of research, and what are the limits of the research. This is necessary to protect scientific integrity.

Since, scientific integrity is the most important aspect of research collaboration, regardless of whether it is between academic researchers or industry, both industry and academia should allow science to be an arbitrator. In other words, science not politics and economics should be the overriding judge in matters of academic integrity and intellectual autonomy.

4. That in some instances there is the lack of distance between results and company interest. This is not good for scholarly work since universities are public entities that must maintain balance as independent critics of society.
5. That industrial sponsored research involves applied science and therefore, there is the need for the government to increase funding for basic science.
6. Since, industrial research brings in money to the university and the departments, academic scientists whose careers are delayed because of publication delays due

to confidentiality agreements must be evaluated in other ways. This will encourage university-industry partnership.

In light of the above, recommendations for further study cannot be overstated. There is the need to direct research activities at assessing the impact of university-industry relations across all academic segments—physical, engineering, life sciences, social sciences and the humanities. Such an analysis could also explore how the strengths and diversities of the various departments and colleges are utilized in the recruitment and institutional resource allocation processes. It should, aim at strategically positioning the less endowed departments in the face of constant but persistent budgetary shortfalls. There is the need to minimize cost and spread benefits of university-industry-government relations across campus.

Recent research in the area of social studies of science and technology has largely focused on the commercialization of academic science, technology transfer and intellectual property. This is largely due to the recognition of commercialization in both developed and transitional economies as a catalyst for regional economic development and regeneration. While these dynamics are necessary, it is important that future research fills the gap in the burgeoning literature on commercialization. This research should try to unravel why some institutional frameworks condition either success or failure in translating academic science into regional economic development given an adequate knowledge base and technological dynamics.

Lastly, the *triple helix* model and the survey research method employed in this study are the most appropriate as they enable the combination of both quantitative and qualitative methodologies. However, with regard to the *triple helix*, the specific form of its penetration and the role of government apart from funding and policy formulation are

not very clear and should be seen as a future research area. The fact that the *triple helix* model offers an opportunity for improving the scientific research process and effectively linking scientific research to economic activity in terms of regional socio-economic development cannot, however, be over-emphasized. Indeed arguments about academic scientific knowledge production and capitalization will continue to be debated and dissected across the academic landscape. Hopefully, a strategic direction for public universities will emerge from these intellectual debates.

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Appendices:

I. Academic Faculty Questionnaire:

SURVEY CONSENT FORM

You are invited to participate in a study entitled: *Scientific Research and Economic Activity: The Role of University-Based Research Innovators in the Production and Capitalization of Knowledge*. Please read this form carefully, and feel free to ask questions you might have.

The study sought to understand the formal and informal transformations of academic knowledge production and capitalization at the University of Saskatchewan. The study is a survey research that revolves around original data collection through the administration of questionnaires to a sampled academic faculty in Life Sciences, Physical Sciences, Engineering Sciences and selected researchers from ten companies located at the Innovation Place Research cluster. Through a purposive sampling procedure, you have been selected as one of the respondents to represent the views of knowledge producers like yourself. Your participation in this survey is voluntary.

The questionnaire takes about 20 minutes to complete. Academic faculty at the University of Saskatchewan and research scientists from the Innovation Place should complete it. You can be assured that all information obtained will be used for statistical purposes only and your identity will not be known. Though demographic data is required it will be analyzed as aggregate data to look only at the gender dimensions of science. As such, in the thesis and any future publications that will emanate from this, only aggregate data will be reported.

The University of Saskatchewan Behavioural Sciences Research Ethics Board has approved this study on ethical grounds on **March 9, 2005** and you have until **June 30, 2005** to complete the questionnaire in case you volunteer to participate in this study. If you have any questions about your rights as a subject participating in the study of this nature, you may call the **Office of Research Services (966-2084)**. For more information on the study itself, you could contact:

The Research Supervisor:
Dr. Zaheer Baber, Associate Professor
Department of Sociology
University of Saskatchewan
Tel: 966- 7437
Email: zaheer.baber@usak.ca

Or the Student Researcher:
Mr. James S. Dzisah
Department of Sociology
University of Saskatchewan
Tel: 966-8835
Email: james.dzisah@usask.ca

Please complete the enclosed questionnaire and return it to us. The researchers will take all possible precautions to protect your confidentiality and anonymity. However, absolute confidentiality cannot be guaranteed. You may, however, withdraw from the study for any reason, at any time, without penalty of any sort. You may refuse to answer individual questions without loss of relevant entitlements, without it affecting your academic or employment status in any way, and without losing access to any relevant services. Completion of the survey will however, constitute your informed consent for participation in this research. Please do not put your name or other identifying information on the questionnaire. You may obtain a summary of the findings through the thesis that will be deposited at the Main Library of the University of Saskatchewan when it is completed. Your co-operation is greatly appreciated!

This questionnaire is designed to solicit information purely for academic purposes. The researcher understands and respects all ethical issues about the conduct of human and behavioural research at the University of Saskatchewan. All information provided would be treated confidentially and anonymously. Data from this research will be reported only in aggregate form and will not be used for any other purpose other than academic research work. By participating in this study, you are not only contributing to the advancement of an academic career, but also more importantly, contributing immensely towards the understanding of one of the thorny issues of today, the production and capitalization of academic scientific knowledge.

Instruction: Please circle the appropriate response in the case of the close-ended questions and write out your responses in full besides the open-ended questions.

A. Research and Teaching Activities

1. Sex...
2. Age....
3. What is your **highest** level of Education? (Select or state the one that appropriately describes your qualification).
 1. Ph.D.
 2. D.Phil
 3. M.A.
 4. MSc.
 5. M.Eng.
 6. Other (Specify).....
4. What is your rank? (Select or state the one that appropriately describes your position).
 1. Professor
 2. Associate Professor
 3. Assistant Professor
 4. Other (Specify).....

5. What is your academic department?.....
6. What are the main sources of your research grants or funds both commercial and non-commercial?

Commercial

Non-Commercial

- 1.....
- 1.....
- 2.....
- 2.....
- 3.....
- 3.....
- 4.....
- 4.....

B. The Capitalization of Knowledge

7. Have you or your graduate student(s) been funded by a private commercial company?
 1. Yes
 2. No
8. If yes to question # 7 above, who decides the topic to be studied by your student(s) in a private commercial company funded research?
9. What form does the research collaboration between you and private commercial companies' often take?
 1. The supply of research materials
 2. The provision of research funds.
 3. Industrial training for your students
 4. The use of the sponsoring company's equipments
 5. Analysis of results for you by the staff of the sponsoring private commercial company
 6. Other (specify).....

10. What do you think of the increasing funding of academic research by private commercial companies?

1. threatening teaching in the university
2. leading to the privatization of the university
3. leading to the displacement of academic criteria by economic criteria in the allocation of resources to various departments
4. increasing the research intensiveness of the university
5. enhancing teaching and learning in the university
6. leading to the judicious and responsible use of research funds
7. cannot choose

Please feel free to provide any additional commentary:

11. How many patents have you produced?

12. Has there been a spin-off company based on your research?

1. Yes
2. No

13. If **yes** to #12 above, who established the spin-off company out of your research?

1. You (the Professor)
2. The University of Saskatchewan
3. A private commercial company
4. A joint venture between you and the University of Saskatchewan
5. A joint venture between you and a private commercial company
6. None of the above
7. Other (Specify).....

Please feel free to provide any additional commentary:

14. Do you think private commercial companies have too much power in determining the university research agenda?

1. Strongly too much power.....
2. Too much power.....
3. About the right amount of power.....
4. Too little power.....
5. Far too little power.....
6. Can't choose.....

15. Do you think economic criteria are displacing academic criteria in the allocation of institutional resources?
1. strongly agree
 2. agree
 3. neither agree nor disagree
 4. disagree
 5. strongly disagree
16. Do you think the recruitment of academic faculty is based on the ability to attract corporate research dollars to departments?
1. strongly agree
 2. agree
 3. neither agree nor disagree
 4. disagree
 5. strongly disagree
17. Do you think university scientists who conduct private commercial company sponsored research are surrendering their intellectual autonomy to these influential patrons?
1. strongly agree
 2. agree
 3. neither agree nor disagree
 4. disagree
 5. strongly disagree
18. Do you think that the increasing use of university facilities by private commercial companies is leading to the 'privatization' of the university?
1. strongly agree
 2. agree
 3. neither agree nor disagree
 4. disagree
 5. strongly disagree
19. Do you think research collaboration between university-industry-government relegates basic or pure research into the background?
1. strongly agree
 2. agree
 3. neither agree nor disagree
 4. disagree
 5. strongly disagree

20. Do you think funds from private commercial companies towards university research are being **fairly** distributed across Faculties and Departments in the University of Saskatchewan?

1. strongly agree
2. agree
3. neither agree nor disagree
4. disagree
5. strongly disagree

21. List the benefits you derive from university-private commercial company research collaboration?

22. What do you think are the disadvantages of university- private commercial company research collaborations?

23. Generally, what do you think about university-industry-government research collaboration?

II. Innovation Place Questionnaire:

SURVEY CONSENT FORM

You are invited to participate in a study entitled: *Scientific Research and Economic Activity: The Role of University-Based Research Innovators in the Production and Capitalization of Knowledge*. Please read this form carefully, and feel free to ask questions you might have.

The study sought to understand the formal and informal transformations of academic knowledge production and capitalization at the University of Saskatchewan. The study is a survey research that revolves around original data collection through the administration of questionnaires to a sampled academic faculty in Life Sciences, Physical Sciences, Engineering Sciences and selected researchers from ten companies located at the Innovation Place Research cluster. Through a purposive sampling procedure, you have been selected as one of the respondents to represent the views of knowledge producers like yourself. Your participation in this survey is voluntary.

The questionnaire takes about 20 minutes to complete. Academic faculty at the University of Saskatchewan and research scientists from the Innovation Place should complete it. You can be assured that all information obtained will be used for statistical purposes only and your identity will not be known. Though demographic data is required it will be analyzed as aggregate data to look only at the gender dimensions of science. As such, in the thesis and any future publications that will emanate from this, only aggregate data will be reported.

The University of Saskatchewan Behavioural Sciences Research Ethics Board has approved this study on ethical grounds on **March 9, 2005** and you have until **June 30, 2005** to complete the questionnaire in case you volunteer to participate in this study. If you have any questions about your rights as a subject participating in the study of this nature, you may call the **Office of Research Services (966-2084)**. For more information on the study itself, you could contact:

The Research Supervisor:
Dr. Zaheer Baber, Associate Professor
Department of Sociology
University of Saskatchewan
Tel: 966- 7437
Email: zaheer.baber@usak.ca

Or the Student Researcher:
Mr. James S. Dzisah
Department of Sociology
University of Saskatchewan
Tel: 966-8835
Email: james.dzisah@usask.ca

Please complete the enclosed questionnaire and return it to us. The researchers will take all possible precautions to protect your confidentiality and anonymity. However, absolute confidentiality cannot be guaranteed. You may, however, withdraw from the study for any reason, at any time, without penalty of any sort. You may refuse to answer individual questions without loss of relevant entitlements, without it affecting your academic or employment status in any way, and without losing access to any relevant services. Completion of the survey will however, constitute your informed consent for participation in this research. Please do not put your name or other identifying information on the questionnaire. You may obtain a summary of the findings through the thesis that will be deposited at the Main Library of the University of Saskatchewan when it is completed. Your co-operation is greatly appreciated!

This questionnaire is designed to solicit information purely for academic purposes. The researcher understands and respects all ethical issues about the conduct of human and behavioural research at the University of Saskatchewan. All information provided would be treated confidentially and anonymously. Data from this research will be reported only in aggregate form and will not be used for any other purpose other than academic research work. By participating in this study, you are not only contributing to the advancement of an academic career, but also more importantly, contributing immensely towards the understanding of one of the thorny issues of today, the production and capitalization of academic scientific knowledge.

Instruction: Please circle the appropriate response in the case of the close-ended questions and write out your responses in full besides the open-ended questions.

A. Research/Administrative Activities:

1. Sex...
2. Age....
3. What is your highest level of Education? (Select or state the one that appropriately describes your qualification).
 1. Ph.D.
 2. M.A.
 3. MSc.
 4. M.Eng.
 5. BSc.
 6. Other (Specify).....

4. What is your rank? (Select or state the one that appropriately describes your position).

1. Chief Executive Officer
2. Senior Research Fellow
3. Research Fellow
4. Research Assistant
5. Laboratory Technician
6. Other (Specify).....

5. What Company/research institute/ organization do you work for?.....

6. Has your company undertaken any research work for any academic Department or Professor of the University of Saskatchewan?

1. Yes
2. No

Please feel free to provide any additional commentary:

7. If **yes** to question #6 above, how many times have you undertaken such research works for Departments or Professors of the University of Saskatchewan?

1. once
2. 2 to 5 times
3. 6 to 10 times
4. 11 to 20 times
5. more than 20
6. Other (specify).....

8. Has your company provided any kind of support to any academic departments/ professors or students at the University of Saskatchewan?

1. Yes
2. No

9. If **yes** to question # 8 above, what form does the research collaboration between your company and academic departments/professors/students at the U of S often take?

1. The supply of research materials
2. The provision of research funds to departments, Professors and Students
3. Industrial training for students
4. The use of your industry's equipments
5. Analysis of results by your company for academic professors
6. Other (specify).....

10. If **yes** to question #8 above, who determines the research topic funded?
11. If **yes** to question #8 above, what is the formula for sharing the returns on the sponsored research?
12. Are there any formal mechanisms for the conduct of research and the exchange of ideas between your company and academic departments and professors of the University of Saskatchewan?
1. Yes
 2. No

Please feel free to provide any additional commentary:

B. The Capitalization of Knowledge

13. Has your company hold a patent emanating from a research activity sponsored in the University of Saskatchewan?
1. Yes
 2. No

Please feel free to provide any additional commentary:

14. Has the University of Saskatchewan established any spin-off firm out of any academic research sponsored by your company?
1. Yes
 2. No

Please feel free to provide any additional commentary:

15. Some people think economic criteria are displacing academic criteria in the allocation of institutional resources
1. strongly agree
 2. agree
 3. neither agree nor disagree
 4. disagree
 5. strongly disagree

16. Selecting the most appropriate answer, do you think the infusion of funds by private commercial companies like yours through the development of new ways of risk sharing and investment is:
1. Increasing research output in the University of Saskatchewan
 2. leading to the privatization of the university
 3. leading to the displacement of academic criteria by economic criteria in the allocation of resources to various departments
 4. enhancing teaching and learning in the university
 5. threatening teaching in the university
 6. Can't choose

Please feel free to provide any additional commentary:

17. Do you think the presence of university-based research incubators such as the 'Innovation Place' leads to the use of university facility by the tenant companies' to maximize their profit?
1. strongly agree
 2. agree
 3. neither agree nor disagree
 4. disagree
 5. strongly disagree
18. Do you think academic professors who work on private commercial company funded research threaten the integrity of the university?
1. strongly agree
 2. agree
 3. disagree
 4. neither agree nor disagree
 5. strongly disagree
19. Do you think research collaboration between university-industry-government makes non-market worthy knowledge irrelevant?
1. strongly agree
 2. agree
 3. neither agree nor disagree
 4. disagree
 5. strongly disagree
20. Do you think university-industry partnerships are leading to the disappearance of basic research in favour of applied research?
1. strongly agree
 2. agree
 3. neither agree nor disagree
 4. disagree
 5. strongly disagree

21. Comment of the assertion that private companies like yours are determining the research agenda because they are providing funding to academic Departments and professors?
22. What benefits in your opinion can be derived from 'Innovation Place' and University of Saskatchewan research collaboration?
23. Generally, what is your opinion on university-industry-government innovation agenda?

III. Academic Faculty Structured In-depth Interview

In-depth Structured Interview Questions for Academic faculty

1. Are university faculty and administrators' close working relationship with private industry threatening the core functions of the university?
2. Are economic criteria displacing academic criteria in the recruitment of academic faculty as the university administrators and academic faculty adopts values and practices of corporate management?
3. Do you think the presence of university-based research innovators such as the innovations place or synchrotron lead to the commercialization of academic research?
4. (a) Is there a conflict of interest between the public nature of the university and research partnership with private industries?

(b) How can we minimize potential conflict of interest?
5. Does private funding of university research relegate 'curiosity-driven/basic research' into the background?
6. Do you think discipline-based research is disappearing as a result of the infusion of funds from private industry?

IV. Copy of Ethics Approval



UNIVERSITY OF SASKATCHEWAN BEHAVIOURAL RESEARCH ETHICS BOARD

<http://www.usask.ca/research/ethics.shtml>

NAME: Zaheer Baber (James Sefe Dzisah)
Sociology


Beh # 05-03

DATE: March 9th, 2005

The Behavioural Research Ethics Board has reviewed the revisions to the Application for Ethics Approval for your study "Scientific Research and Economic Activity: The Role of University-based Research Innovators in the Production and Capitalization of Knowledge" (Beh #05-03).

1. Your study has been APPROVED.
2. Any significant changes to your proposed study should be reported to the Chair for Committee consideration in advance of its implementation.
3. The term of this approval is for 5 years.
4. This approval is valid for five years on the condition that a status report form is submitted annually to the Chair of the Committee. This certificate will automatically be invalidated if a status report form is not received within one month of the anniversary date. Please refer to the website for further instructions: <http://www.usask.ca/research/ethics.shtml>

I wish you a successful and informative study.


Dr. Valerie Thompson, Chair
Behavioural Research Ethics Board

VT/cc

Office of Research Services, University of Saskatchewan
Room 1607, 110 Gymnasium Place, Box 5000 RPO University, Saskatoon SK S7N 4J8 CANADA
Telephone: (306) 966-8576 Facsimile: (306) 966-8597
<http://www.usask.ca/research>